GoNorth

GEOSCIENCES IN THE NORTHERN ARCTIC

Cruise Report

29 August–19 September 2024



About this report

Cruise leaders: Bjørg Risebrobakken, NORCE, and Jan Sverre Laberg, UiT

Image on front page: Daniel Albert, SINTEF/GoNorth

Bjørg Risebrobakken[1] and Jan Sverre Laberg[2] (Eds.)

With contributions from:

Shipboard scientific party: Daniel Albert[3], Nicki Riber Andreasen[4], Dag Inge Blindheim[1], Hannah Rose Babel[5], Thomas Funck[6], Katja Häkli[1], Frank Werner Jakobsen[2], Md Ashiqul Alam Khan[7], Alexander Minakov[8], Stig Monsen[5], Bjørn Runar Olsen[2], Lars Mejlgaard Rasmussen[6], Jasmin Schönenberger[9], Cecilie Thaarup[10], Amandine Tisserand[1], Per Trinhammer[11] and Oskar Gjesdal Veggeland[7].

Project PIs: Bodil Bluhm[2], Stefan Bünz[2], Stijn De Schepper[1], Thomas Funck[6], Carmen Gaina[8], Steffen Leth Jørgensen[5], Ekaterina Kim[7], Jochen Knies[2,9], Riko Noormets[10], Agnes Weiner[1] and Monica Winsborrow[2]

GoNorth management: Øyvind Paasche[1] and Margit Simon[1]

Final editing and formatting: Lucía Gutiérrez-Loza[1]

[1] NORCE, Norwegian Research Institute AS, Norway (NORCE)
[2] University of Tromsø - The Arctic University of Norway, Norway (UiT)
[3] SINTEF, Norway
[4] Geodatastyrelsen, Denmark (GST)
[5] University of Bergen, Department of Earth Sciences, Norway (UiB)
[6] De Nationale Geologiske Undersøgelser for Danmark & Grønland, Denmark (GEUS)
[7] Norges teknisk-naturvitenskaplige Universitet, Norway (NTNU)
[8] University of Oslo, Department of Geosciences, Norway (UiO)
[9] Geological Survey of Norway, Norway (NGU)
[10] The university centre in Svalbard, Norway (UNIS)
[11] Aarhus University, Denmark (AU)



Septentrio Reports (3) 2026
https://doi.org/10.7557/7.9027

This work is licensed under a Creative Commons Attribution 4.0 International License.

Forord

Arktis er av stor betydning for Norge. Vi står som forvaltere av en region i rask endring grunnet store klimaforandringer, men som er rik på ressurser. I 2009 ble Norges krav om kontinentalsokkelområder nord for Svalbard anerkjent av FNs kontinentalsokkel-kommisjon. Vår kunnskap om den norske sokkelen likevel fortsatt begrenset.

GoNorth-programmet er etablert for å mobilisere de fremste kunnskapsmiljøene in landet kunnskap om, for og i Polhavet. Målet er å posisjonere Norge som den ledende forvalter av miljøet og naturressursene i regionen. For å oppnå dette vil vi samarbeide med internasjonale fagmiljøer som deler våre interesser og ambisjoner, og som er villige til å samarbeide om forskning, fartøyer og finansiering.

Det første GoNorth-toktet startet fra Longyearbyen 15. oktober 2022 med kurs mot Nordmarginen av Svalbard, Nansen-bassenget og Knipovich-ryggen vest for Svalbard. Tokt nummer to gikk fra Longyearbyen 7. juli 2023 med kurs for den nordligste delen av midthavsryggen mellom Svalbard og Grønland. Denne rapporten oppsummerer det tredje toktet med forskningsfartøyet Kronprins Haakon på vegne av partnerskapet. Jan Sverre Laberg, professor ved UiT Norges arktiske universitet, og Bjørg Risebrobakken, Forsker I ved NORCE, var toktledere om bord og hadde også redaktøransvar for rapporten.

Årets GoNorth tokt har kartlagt havbunnen i Arktis, spesielt nordøst for Grønland. Et sentralt forskningsmål, som en del av samarbeidet med GEUS, var å dokumentere Danmarks utvidelse av kontinentalsokkelen i samarbeid med norske og internasjonale eksperter. Multistråleekkolodd ble brukt til å samle nøyaktige 3D-bilder av havbunnen, mens gravimetre ble anvendt for å oppdage strukturer under havoverflaten.

Under ekspedisjonen ble det lagt stor vekt på Independence Fjord, et lite kartlagt området før dette oppdraget. Teamet samlet inn en serie med sedimentkjerner for å studere tidligere miljøforhold, med særlig fokus på sedimentlag som gir innsikt i historisk omfattende endringer i temperatur, isdekke og biologisk aktivitet. Dette arbeidet er avgjørende for å forstå Arktis' geologiske historie og dets potensial for ressursforvaltning. Toktet representerer et betydelig fremskritt innen Arktis-forskning, hvor banebrytende teknologi kombineres med internasjonalt samarbeid.

Vi vil gjerne takke Nærings- og fiskeridepartementet, Utenriksdepartementet og Kunnskapsdepartementet for økonomisk støtte til gjennomføringen av årets tokt. Takk også til universitetene i Bergen og Tromsø for deres bidrag med finansierte toktdøgn. Vi ønsker også å uttrykke vår takknemlighet til kapteinene og mannskapet om bord på Kronprins Haakon for utmerket samarbeid underveis. Sist, men ikke minst, takker vi partnerskapet i GoNorth, spesielt prosjektets vitenskapelige kjernegruppe og tidligere prosjektleder Gunnar Sand, for god planlegging og koordinering av ulike interesser over mange år.

Bergen, 18. september 2024

Øyvind Paasche,
prosjektleder for GoNorth og
Leder, Avd. for Klimadynamikk ved NORCE
&
Margit Simon,
prosjektkoordinator for GoNorth
og Forsker ved NORCE

Sammendrag

Klima i Arktis endrer seg. Svalbard og havområdene rundt Svalbard er der de raskeste endringene skjer. Sjøisgrensen flytter seg stadig lenger nordover, og det skjer en atlantifisering av vannmassene i polhavet. Endringene i havet vil igjen påvirke biologisk liv og aktivitet. Endringene som skjer i østlige deler av Fram Stredet, der varmt og salt Atlantisk vann strømmer inn i Polhavet er også viktige for hva som skjer vest i Fram Stredet, der kaldt, ferskere vann strømmer ut av Polhavet. I tillegg vil økt innstrømning av atlantisk vann inn i fjordene på NØ Grønland kunne bidra til smelting og tilbaketrekning av Grønlandsisens utløpere der disse terminerer i havet. Hvor raskt dette vil skje avhenger også av fjordbunnens morfologi, som er dårlig kartlagt.

Prediksjonene viser at Polhavet vil være isfritt i september nær midten av det 21 århundre, under lave eller intermediære utslippsscenarier. Projeksjonene gir indikasjoner på hva som kan skje i fremtiden, men ved å rekonstruere de klimatiske og miljømessige forholdene i Polhavet slik de var under tidligere varmeperioder kan vi få informasjon om hvilke endringer som kan forventes i fremtiden.

Over geologisk tid har Polhavet opplevd store endringer, fra å være et isolert ferskvannsbasseng har det over millioner av år åpnet seg til ett åpent basseng med utveksling av vannmasser med Atlanterhavet gjennom Fram Stredet, Barentshavet og Nares Stredene og til Stillehavet gjennom Beringstredet. Når og hvordan utviklingen fra å være ett lukket til åpent basseng skjedde er fortsatt dårlig forstått, først og fremst på grunn av mangel på geologiske og geofysiske data.

Å skaffe materiale og data som forteller om Polhavets fortiden er krevende. Området er vanskelig tilgjengelig. Å komme seg dit krever spesialbygde, isgående forskningsfartøy med avansert utstyr.

GoNorth har som målsetning å skaffe økt kunnskap om Polhavet. I utgangspunktet var det planlagt for tre tokt med FF *Kronprins Haakon*. Dette er det tredje av disse tre toktene. Det første ble arrangert i 2022 og det andre i 2023. Det har vært en målsetning at alle toktene skulle være multidisiplinære, og at en rekke ulike fagdisipliner og prosjekter deltar på toktene. De samme dataene kan gi grunnlag for ulike typer studier, og det kan også oppdages og utvikles nye synergier underveis på toktet. Toktet setter dermed ramme for mulige nye samarbeid og forskningsretninger. På den måten får man ett større utbytte av toktet enn om bare en type aktivitet eller ett prosjekt skulle samle data. Forskerutdanning er også viktig for GoNorth. På årets tokt har det vært med 5 stipendiater, alle på ulike stadier av doktorgradsarbeidet sitt.

Årets tokt startet i Longyearbyen 29 august og sluttet i Longyearbyen 19 september. Med på toktet var der 19 forskere og teknikere fra elleve ulike institusjoner. Vi hadde også med en person som jobbet med formidling og en sykepleier.

I løpet av toktet tok vi sedimentkjerner fra havbunnen på marginen av Svalbard og nordøst Grønland, i Independence og Hagen fjordsystemet, videre ut fra fjordene og ned skråningen av nordøstgrønland marginen, Framstredet mot Amundsenbasenget og Yermak Platået. I tillegg ble det gjort kontinuerlige gravimetri og batymetri målinger langs hele seilingsruten. Store deler av områdene har ikke tidligere vært kartlagt på denne måten. Det er også gjort autonome observasjoner av sjøis fortløpende underveis.

Her presenteres de som deltok på toktet og aktivitetene som ble utført. Materialet som er samlet vil danne grunnlag for viktig forskning i mange år fremover, og i stor grad øke vår kunnskap om Arktis, hvordan Polhavet har utviklet seg og hvordan oseanografien og biodiversiteten har endret seg gjennom tid.

Vi hadde med oss ett fantastisk godt mannskap på F/F Kronprins Haakon, som alle var med på å gjøre dette til ett meget bra tokt. Vi setter stor pris på den positive holdningen, det godt samarbeidet, den gode kommunikasjonen og gode forpleiningen som har gjort det til en veldig god opplevelse å være ombord.

Bjørg Risebrobakken, NORCE og Jan Sverre Laberg, UiT

Toktledere for GoNorth 2024, September 2024

Contents

About this report **2**
Forord **3**
Sammendrag **4**
1. Crew onboard R/V Kronprins Haakon **8**
1.1 Scientific crew 8
1.2 R/V Kronprins Haakon crew 8
2. Cruise stations and transects **9**
3. Cruise diary **10**
4. Work onboard **16**
4.1 Sub-bottom profiling to detect suitable stations for sediment coring 16
4.2 CTD and water sampling 17
4.3 Sediment coring 20
4.3.1. Multi coring 20
4.3.2. Gravity coring 24
4.4 Plankton net 26
4.5 Heat flow measurements 26
4.6 Gravimetry 28
4.7 Bathymetry/water column data 29
4.7.1. Patch test of multibeam echosounder Kongsberg EM302 30
4.7.2. Acquisition software, parameters and auxiliary sensors 30
4.7.3. Sound speed 31
4.7.4. Underway data processing 31
4.8 Seismic 32
4.9 Magnetometer 35
4.10 Shipborne instrumentation for sea ice analysis 35
4.10.1. Side-looking ice mapping systems 36
4.10.2. Ice thickness measurement 37
5. Dissemination **40**
6. Projects onboard **41**
6.1 iC3 - Centre for Ice, Cryosphere, Carbon and Climate 41
6.2 i2B - Into the Blue – Resolving past Arctic greenhouse climate 41
6.3 DYPOLE - Dynamics of polar confined basins – The Eurasia Basin from breakup in greenhouse to present in icehouse conditions 41
6.4 AGENSI – A Genetic View Into Past Sea Ice Variability in the Arctic 42
6.5 Continental Shelf Project of the Kingdom of Denmark 42

6.6 Climate change, ice dynamics and carbon cycle across the Svalbard-North Greenland transect, PhD project at UNIS..... 43
6.7 PASTIME, Fjo2rd and CLIFORD.....43
6.8 beAt - Microbial response to Arctic climate variability.....44
6.9 Benthic meiofauna sampling for SUDARCO (Sustainable Development of the Arctic Ocean).....44
6.10 Intelligent local-scale observations and analytics.....44
6.11 Heat Flow Measurements.....45
7. Abbreviations.....46
8. Appendices..... 48

1. Crew onboard R/V Kronprins Haakon

1.1 Scientific crew

Table 1: Scientific crew of the GoNorth 2024 expedition. UiT: University of Tromsø - The Arctic University of Norway, GEUS: De Nationale Geologiske Undersøgelser for Danmark & Grønland, AU:Aarhus University, GST: Geodatastyrelsen, UiO: University of Oslo, UiB: University of Bergen, NTNU: Norges teknisk-naturvitenskaplige Universitet, NGU: Geological Survey of Norway.

Name	Institution	Role
Jan Sverre Laberg	UiT	Cruise leader
Bjørg Risebrobakken	NORCE	Cruise leader
Thomas Funck	GEUS	Scientist
Per Trinhammer	AU	Technician
Lars Mejlgaard Rasmussen	GEUS	Technician
Nicki Riber Andreasen	GST	Hydrographer
Alexander Minakov	UiO	Scientist
Dag Inge Blindheim	NORCE	Technician
Amandine Tisserand	NORCE	Technician
Bjørn Runar Olsen	UiT	Technician
Katja Häkli	NORCE	Technician
Stig Monsen	UiB	Technician
Frank Werner Jakobsen	UiT	PhD student
Cecilie Thaarup	UNIS	PhD student
Hannah Rose Babel	UiB	PhD student
Oskar Gjesdal Veggeland	NTNU	PhD student
Md Ashiqul Alam Khan	NTNU	PhD student
Jasmin Schönenberger	NGU	Scientist
Daniel Albert	SINTEF	Communication
Ståle Skaaden	HRC personalhuset	Medic

1.2 R/V Kronprins Haakon crew

Table 2: Ship crew onboard R/V Kronprins Haakon during GoNorth 2024 expedition.

Name	Role
Karl Robert Røttingen	Captain
Ove Remme	Chief officer
Tor Inge Larsen	1st officer
Knut Tarberg	Chief engineer
Morten Innvær	1st engineer
Benjamin Farstad Knotten	2nd engineer
Mathias Molvik	Electrician
Andreas Wolden	Fishing master
Torben Pedersen	Net man
Knut Ivar Hansen	Able seaman
Tom Odin Ditlefsen	Able seaman
Per Bær	Able seaman
Tommy Austevoll	Able seaman
Marius Hufthammer	Engine apprentice
Kenneth Reece	Chief steward
Cato Paulsen	Cook
Gunn Monica Røttingen	Catering assistant
Rebecca Torsvik	Catering assistant
Lage Drivenes	Instrument chief
Eivind Ernstsen	Instrument technician

2. Cruise stations and transects

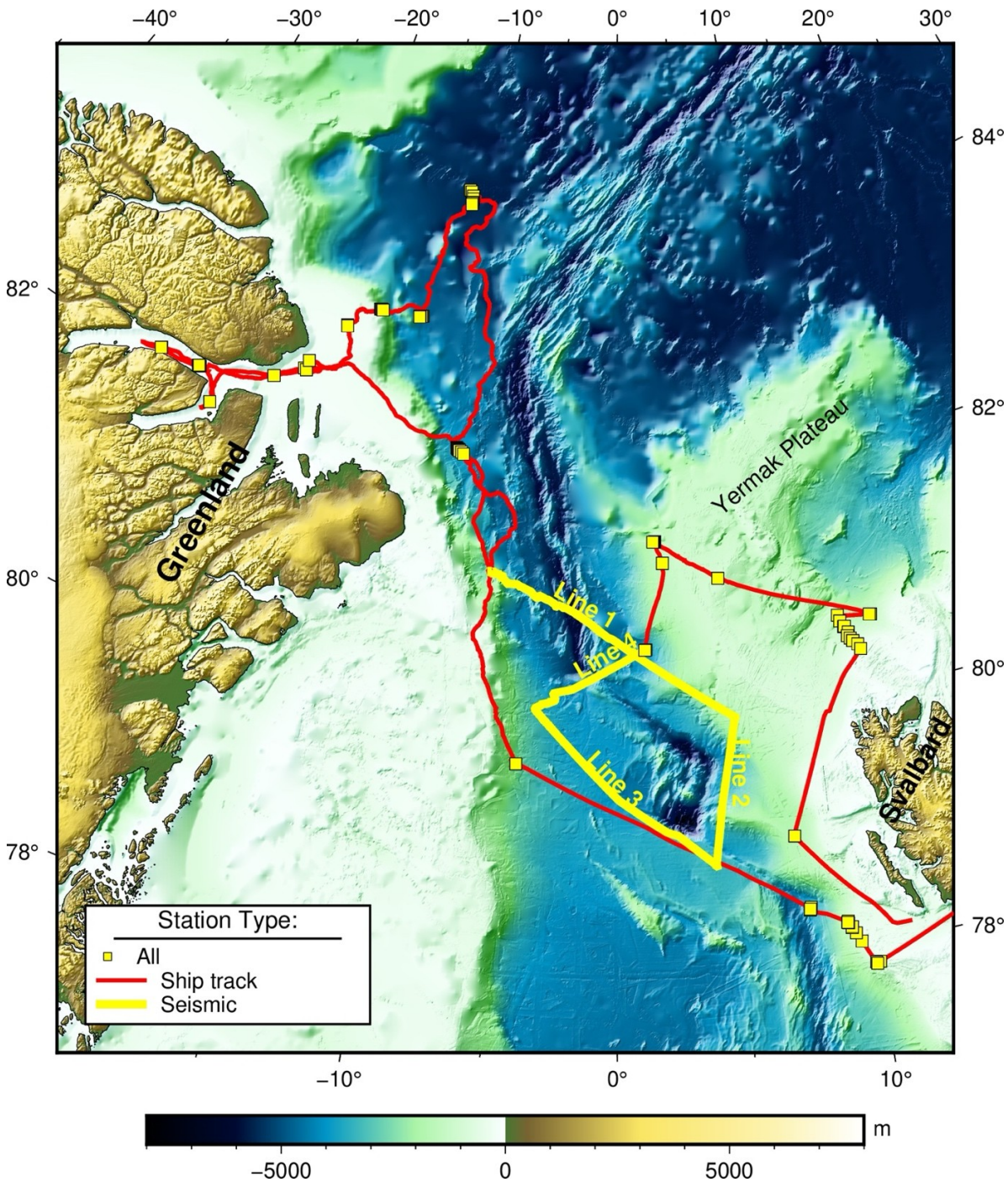


Figure 1: Map showing stations and transects where data have been collected. Each yellow square indicate one activity at a station. At most stations more than one activity were done, and where it looks like a stack of activities it reflect drift while at a station.

3. Cruise diary

Pre-cruise activities in Longyearbyen

The day before we got access to R/V Kronprins Haakon, all participants were on place in Longyearbyen. Some of the participants did their survival suite training at UNIS. From lunch onwards we met at the Raddisson Blue Polar Hotel Spitsbergen hotel for a seminar, presenting the projects and activities planned for the cruise. The Longyearbyen RCN (The Research Council of Norway) representative joined for part of the meeting.

Day 1 – 29 August

We entered the ship early morning and got installed to our cabins. Loading of equipment started, as it gradually found its way to Bykaia, Longyearbyen. After lunch we had an information meeting with the captain, being introduced to the ship and its routines. We were also informed about safety regulations and requirements for resting time. Following the information meeting we had our first daily briefing as a scientific team. Use and distribution of lab and office space for the different activities was discussed and settled. The meeting ended with around checking status for the equipment to be loaded.

And then the problems began. Though the morning, there had been a search for equipment to be used by UiB, as well as the Calypso giant piston corer. All missing equipment was in the end located in Tromsø. It had not made the last leg off shipping.

Long story short, the result was that no piston coring was done during the cruise. It would take too much time to get it transported to Longyearbyen or to go back to Longyearbyen and pick it up later. With only three weeks of available ship time this was not considered an option. We had to get started as the sea ice conditions in our working area was very favourable. Importantly though, we realised that we would have to think positively and adapt our plans to facilitate as much activity as possible. It opened a potential for more multi- and gravity-core sites, and survey of areas not often visited.

The UiB box could arrive by plain the following day. If we should leave without it, it would have meant skipping all UiB sites. In plan A we had acknowledged that the mobilisation may take two days. Accordingly, we decided to wait for the UiB box to arrive the following day. We also discussed, and initiated, what work could be done onboard while waiting, that would save time later.

Day 2 - 30 August

The UiB box was located, transported to the airport, checked in and arrived in Longyearbyen. with the plain landing just before 14:00. It was picked up personally to ensure efficiency. One of the two Calypss core technicians from the Institute of Marine Research (IMR) left as there were no longer need for both onboard.

Onboard work continued to prepare for what’s to come. The compressors were tested. The magnetometer was connected and tested. Different sedimentary lab stations were set up and made ready for the work to come. Work was done to prepare the UiT multicorer (MC) and the camera connections, as well as to set up the UiB MC and make ready tubes to be used. One CTD station was taken in connection with the multibeam patch testing (considered station KH24-259-01, but we learned later that it was not logged).

At the scientific briefing, all got an update on status, presentation of work to be done at the first four coring stations, discussions on details with respect to the procedures, instrumentation, how to move into shifts, etc.

At the end of the day, we started transit towards the first coring station at the western Svalbard shelf area.

Day 3 – 31 August

The first day of sediment coring was intense. We did four stations at the west Spitsbergen margin. At each station, a CTD was taken, with bottom water sampled, and a MC cast. At the second station two MC casts were done to get enough material. At the last two of the four stations a gravity corer (GC) was also cast. All these cores were collected for UiB (PI: Steffen Jørgensen). At the last station we also did heat flow measurements. One multicore from each station and the two gravity cores were split, O_2 measured, and samples were taken for pore fluid and microbiology.

Day 4 – 1 September

The last GC cast from the lower west Spitsbergen margin came up successfully during night. When done at the station, we started the transit to the Northeast Greenland margin. Along the way we tested the magnetometer to make sure that it worked properly, and it did.

In the evening, we started surveying for the next site (PIs: Jochen Knies, UiT/NGU, and Stijn De Schepper, NORCE). This was also planned as a full-scale sediment site, with CTD, MC and GC. The CTD was finished before midnight.

Day 5 - 2 September

The Northeast Greenland margin MC came up successfully with four full tubes. Two GCs were taken. As soon as all equipment and samples were secured on deck, we started the transit northward towards the Northeast Greenland margin, east of the Independence fjord system. While in transit, processing of the first five stations was finished. We met the first signs of sea ice, gradually seeing more as the day proceeded.

As we moved into sea ice areas, we started discussions with the crew on the way forward and how to plan with respect to sea ice conditions. We agreed to check in again the following day, but if there was no change, we would use the favourable sea ice conditions and go straight to the fjords before doing the sites at the shelf/margin. The crew were eager to give the fjords a try, despite unknown bathymetry.

The Swedish ice breaker “Oden” was trying to go north from Victoria fjord on the northern Greenland towards the Morris Jesup Rise. As it looked at that moment, we would likely not get there due to the sea ice conditions, but we decided to keep the dialogue open and suggested meeting at the GEUS northern point instead, if we were able to get there, to work in tandem going south.

Day 6 - 3 September

Oden have turned around, moving south again rather than north, to end their cruise in Thule (Greenland). They did not manage to keep more than 1 nm due to sever sea ice conditions. The consequence is that we abandoned trying to reach Morris Jesup Rise. However, we decided to keep the northern GEUS profiles in the plan. Final discussions and decision on this would take place when we were out of the fjords.

We decided to go straight to the fjords as sea ice conditions were good. First, we mapped our way towards the head of the Independence fjord. While mapping we kept a continuous eye on sub-bottom profile and noted potential good coring stations that may be visited on the way back out. On the way back we would follow the same strategy for the Hagen fjord. Hence, the whole day was a day of profiling while in transit. It felt like being an explorer of the old days, as no ship have—to our knowledge—officially mapped or cored the fjord system before. The area was amazingly beautiful. Clear sky and sun, bathing massive ice bergs and sea ice, still in overall quite open seas. We have not yet done any real ice breaking.

Day 7 – 4 September

We continued exploring new territory until the early day. Then, we started the selection process for fjord stations based on the multibeam and sub-bottom profiles. To the originally planned sites we added a few additional ones, to use the opportunity while we had favourable conditions in a so far under-explored fjord system.

The first site was set in the inner basin, close to the originally planned Independence fjord system site. A CTD cast with water sampling at six different depths were done (bottom, 100, 50, 25, 10 and 5 m water depth). Following the CTD, we did a plankton net, MCs and GCs for UiT (PI: Monica Winsborrow) and NORCE (PIs: Bjørg Risebrobakken and Agnes Weiner). The sediments were extremely soupy and exceptionally tricky to sample with the MC. It took us five casts to get what we needed, but then we also found a solution on how to avoid losing the sediment when it came up above water. This solution, closing the flaps manually before leaving the water, helped at later stations as well, saving time at other stations.

Day 8 – 5 September

Steamed towards the second fjord site, in the outer Independence fjord basin. At the station, we did another CTD with water samples from six depths, as well as plankton net, MCs and GCs. As for the previous site and the next two planned sites, material was collected for UiT (PI: Monica Winsborrow) and NORCE (PIs: Bjørg Risebrobakken and Agnes Weiner).

When the second fjord station was done, we started surveying and mapping towards the Hagen fjord. We went halfway in before setting the station. Again, CTD with water samples from six depths, plankton net, MCs and GCs were collected for UiT (PI: Monica Winsborrow) and NORCE (PIs: Bjørg Risebrobakken and Agnes Weiner).

Day 9 – 6 September

We arrived at the next station early, set in an outer fjord basin. Again, CTD with water samples from six depths, plankton net, MCs and GCs were collected for UiT (PI: Monica Winsborrow) and NORCE (PIs: Bjørg Risebrobakken and Agnes Weiner).

When done at the outer basin station, we started transit towards two additional stations in the fjord mouth area, set as alternatives for addressing UNIS interests, as we were unsure on what we would get at the planned shelf and margin sites. Thick sea ice had come into the fjord mouth from the margin, making the transit take more time, and led us to make small adjustments to the position of these two stations.

The first of the stations was very successful and we managed to get a CTD, MCs and a GC for UNIS (PI: Riko Noormets). The second station was less successful. Here, we got a CTD and MC cast with decent material, however, the GC came back slightly bend and with only a short core recovered (ca. 90 cm). The next transit would bring us to the UNIS-planned sites at the shelf/margin of Northeast Greenland.

Day 10 – 7 September

We arrived at the next station, at the Northeast Greenland shelf early in the day. Again, CDT (with water sample) and two MC casts were taken for UNIS (PI: Riko Noormets), UiT (PI: Monica Winsborrow) and NORCE (PI: Bjørg Risebrobakken). The MCs given to UiT and NORCE were additional reference cores to complement their fjord transect cores. The ground was not favourable, so we did not do a GC cast.

When leaving the site, we went through quite extensive ice towards the next station, at the East Greenland margin. The CTD was successful. We did, however, not succeed with the sediment coring. We did two unsuccessful MC casts, the last one with the camera on the UiT corer active. We could then observe a very rocky and extremely steep bottom. It was therefore no point in trying to get a GC or heat flow probe measurements, and we decided to leave the station. The station was originally planned for UNIS (PI: Riko Noormets), NORCE (PI: Stijn De Schepper), and heat flow probe for UiT (PI: Stefan Bünz). The margin was extremely steep, and from the beginning of the work until the end, we moved several hounded of meters (ca 500 m) in water depth (due to sea ice we had to drift and could not stay stationary at a fixed location).

Bathymetry was continuously recorded from the margin towards the start of the GEUS transect. After discussing the sea ice conditions with the crew, we decided to do as much as possible of their northern transects.

Day 11 - 8 September

Arriving at the start point of the western GEUS line, we did a CTD to get a sound velocity profile for the multibeam echosounder to account for sound refraction through the water column. We also did one MC and one GC cast. The day was spend moving northwards along the western GEUS transect. It was a smooth travel, with clear leads in the ice all the way. We reached the northern point around midnight, getting ready for the northernmost coring station.

Day 12 – 9 September

At the end point of the first GEUS transect we had the northernmost coring station of the cruise, just above 84°N. That is far north!

We took one CTD cast, with water samples at four depths. We did two MC casts. The cores recovered were very short. We tried to take a GC as well, as an addition to the GoNorth consortium, since we were at 84°N—and could do it. The GC did, however, come up empty. It was likely sandy sediments draped by a thin mud layer, very difficult to penetrate for the GC. We could see that it had been lying on ground, but there was no sediment, not even in the core catcher.

When all equipment was secured on deck, we continued to map the next GEUS transect.

Day 13 – 10 September

We finished the bathymetric mapping, followed by a transit towards the deeper parts of Northeast Greenland margin where we had the next coring station. The CTD cast and one MC cast were done before midnight. In the first MC cast, we recovered three cores with approximately 20 cm of sediment in each.

Day 14 – 11 September

Crossing over to 11 of September we deployed the UiT MC, providing video footage of the sea floor. Hence, before launching the GC we knew more about the bottom sediment conditions.

The cores retrieved with the UiT MC were also short, suggesting a sandy layer not too deep into the sediment package. To get through the sandy layer, we let the GC hit the sediment at high speed (>1.5 m/s). This approach was successful, and a full-length gravity core was collected. The winds had changed and there was much more sea ice in the area than when we passed by on the way northwards. Due to the sea ice conditions, we drifted a few nautical miles from the time we started the CTD to when we finished the gravity coring, and we also had to find a new hole in the ice before deploying the heat flow probe.

Furthermore, the changes in sea ice conditions meant that we had to move the planned seismic transects further south. To reach the more southern position, most of the day was spend in transit. After intensive coring work earlier in the cruise, the day was used to work on the backlog on digitising information and processing core material.

Just after dinner, we started watching for mammals, in preparation for seismic activities. The people from GEUS prepared for the seismic activity, and gradually we got started on the first line (using the soft start procedure, see more details below), crossing south-eastwards from the Northeast Greenland margin to the West Spitsbergen margin/Southern Yermak Plateau.

Day 15 – 12 September

The seismic activity continued throughout the day and would continue for some days. In parallel, work was done on processing cores collected earlier, checking details, and updating data from previous stations.

For the first time since leaving Longyearbyen, we experienced wavy sea conditions.

Day 16 – 13 September

The seismic activity continued through a rough night, where winds reached 22–23 m/s, or “liten storm”, with the bow heave being up to 10 m—and throughout the day.

Day 17 – 14 September

Yet another day dedicated to seismic activities. We finished Line 2, and Line 3 was well under way by the end of the day.

Day 18 – 15 September

The third seismic line was finished during the morning, while Line 4 was started and finished in the evening. It ended a bit earlier than planned due to the observation of whales in the area (most likely a Blue whale). Since the seismic activities may impact the environment where the whales live, all activity terminates with the observation of mammals. After dismounting the equipment, we started the transit towards the Northwest Yermak Plateau and the three coring sites planned there. Conditions were good throughout the seismic mission, with mostly open waters. Open sea ice conditions were only present when we started Line 1, and towards the later part of Line 3. The magnetometer was retrieved before we met sea ice at Line 3, just after dinner time. At the end of the seismic Line 4, we also did a CTD cast for calibration of the multibeam.

Day 19 – 16 September

We hit more sea ice again on our transit to the first Yermak Plateau station, where we arrived during the night. At this station, we did a CTD cast, two MC casts (PIs: Jan Sverre Laberg, UiT, Stijn De Schepper, NORCE, and Jochen Knies, UiT/NGU), and in the end, four GC casts after one overpenetration. One good GC, and the overpenetrated one, for Jan Sverre Laberg, and two GC for Stijn De Schepper/Jochen Knies, leaving one core undisturbed for sedimentary ancient

DNA (aDNA). The following station was only about two hours of transit away, a station where we took a CTD, a MC and a GC cast (PI: Riko Noormets, UNIS). This second station was done in the afternoon. The rest of the day we were in transit towards the next station, where we expected to arrive early morning, depending on the sea ice conditions.

Day 20 – 17 September

The last of the three Northern Yermak Plateau stations were reached early morning. A CTD, MC and GC cast (PI: Riko Noormets, UNIS) was done. When all equipment was secured onboard again, we started transit to the easternmost site of the cruise, at the southeastern part of the Yermak Plateau. Again, CTD, MC, and this time, two GC casts were done (PIs: Jochen Knies, UiT/NGU, and Stijn De Schepper, NORCE), followed by a heat flow cast (PI: Stefan Stefan Bünz, UiT). In the evening, we set direction slightly westwards where we have set a CTD transect, with some MCs, covering the inflow branch of Atlantic Water through the Yermak Plateau. This transect is set as a GoNorth recourse, where the cruise leaders will coordinate potential interests/requests.

Day 21 – 18 September

The South Yermak transect was finished in the morning. At the shallower locations it was not possible to get any sediment into the MC, but CTDs were done. At one of the shallow stations, we captured one well rounded rock that just fitted into the MC tube. After finalising the transect we started transit towards the last station, at Vestnesa, where a MC and a CTD were taken (PI: Stijn De Schepper, NORCE). Started packing and cleaning up all equipment and labs.

Day 22 – 19 September

After intense packing and cleaning of equipment and labs, we arrived in Longyearbyen around noon. The rest of the day went into getting all finished onboard and getting ready to leave the ship the next morning. Part of the new crew was entering the ship.

Day 23 – 20 September

Most of the scientific crew left to fly back home to their respective homes. The rest of the new crew came onboard, the old crew left the ship.

Day 24 – 21 September

Demobilisations. All equipment was lifted off the ship to the harbour, and later picked up to be send back to the respective institutions.

4. Work onboard

During the cruise, we have collected data using a wide range of scientific methods, each method leading to significant new scientific opportunities and knowledge. Here, an overview of the main type of activities are given, as well as a summary of the individual methods.

4.1 Sub-bottom profiling to detect suitable stations for sediment coring

The Kongsberg SBP 300 Deep Water Sub-bottom profiler has a narrow beamwidth with correspondingly low smearing. It thus provides deep penetration into the bottom, and high angular resolution. The normal transmit waveform is a linear FM pulse. The outer limits for the start and stop frequencies of the FM pulse are 2.5 kHz and 6.5 kHz, providing a maximum vertical resolution of approximately 0.3 ms. The data produced by SBP 300 is logged in the Topas raw format or in the SEG-Y format that allows post-processing by some standard seismic processing software packages.

Outside the 12 nautical mile zone around Svalbard, the Kongsberg SBP300-6 deep-water sub-bottom profiler (SBP) was run continuously as it provides valuable information on sedimentary processes in conjunction with the multibeam bathymetric data. This will allow for the identification of for example sediment waves related to bottom currents, or mass transport deposits. The sedimentation in the Arctic Ocean is primarily controlled by tectonics, oceanography, and processes in the cryosphere. The SBP data provide the tool to decipher those processes. Given the recent focus on landslides and tsunamis in Greenland, like the one in September 2023 in Dickson Fjord associated with a 200-m-high wave, the SBP data in Independence Fjord can be used to identify possible landslides there. Figure 2 shows an example of an SBP record that displays an opaque region interpreted as a mass transport deposit (MTD). The record also shows some very prominent asymmetric sediment waves that were created by ocean bottom currents. Such sediment waves were observed frequently during the expedition.

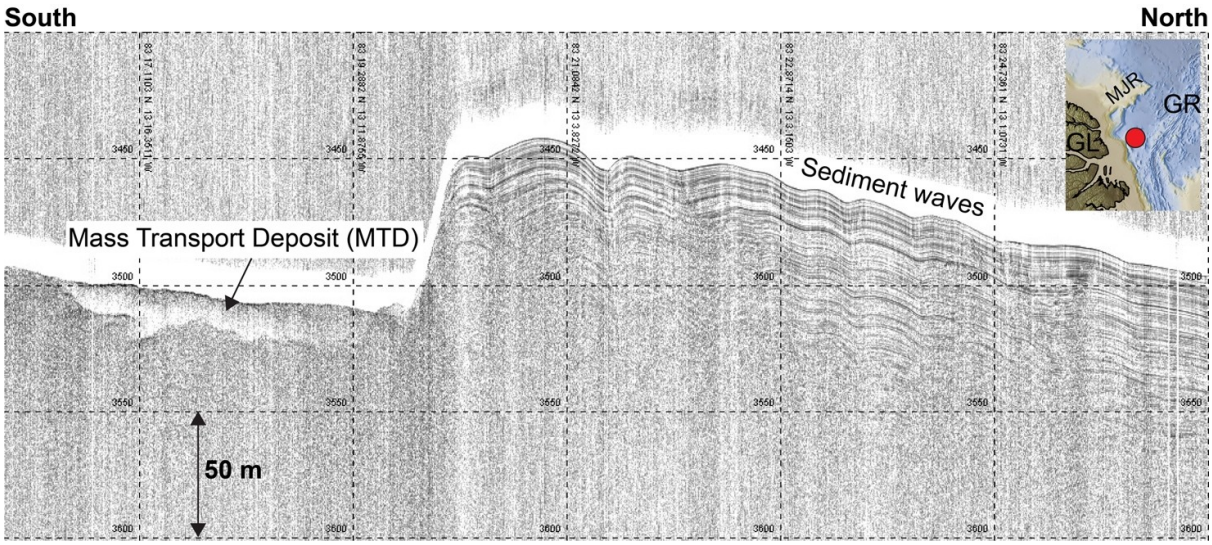


Figure 2: Record of the sub-bottom profiler from September 8, 2024, in the area between Gakkel Ridge (GR) and northern-most Greenland (GL). See inset map for location (red circle). Abbreviation MJR is Morris Jesup Rise. In the south, the semi-transparent facies under the seafloor indicates a mass transport deposit with an irregular bottom as it infills the irregular surface. Beyond the escarpment to the north, asymmetric sediment waves are recorded to a depth of ca. 90 m below the seafloor.

Another reason to run the SBP was to detect suitable coring sites. Before selecting a specific site, a survey was done to map the sediment coverage and detect well developed sediment packages. At most sites recovery was as expected, however, some locations had a harder and/or sandier bottom than anticipated and less sediment was recovered.

The Kongberg SBP300-6 SBP can receive up to 11 beams per ping. At the start of the cruise, only the central beam was used. However, on September 7, 2024, the number of beams was increased to five with a beam spacing of 3 degrees. Two beams each are going to the port and starboard side, in addition to the nadir beam. Multiple beams per ping allow for a better detection of complex sub-bottom structure, for example changing sediment slopes. All beams are stored separately as SEG-Y files; rxp1 and rxp2 denote the port beams in the filenames, rx0 is the centre (nadir) beam, while rxs1 and rxs2 represent the two starboard beams.

4.2 CTD and water sampling

At each sediment sampling station, CTD (conductivity, temperature and depth) measurements were done using an SBE911+ unit with a 12-bottle rosette (Figure 3). At all stations, the CTD was lowered to 10 m above the seafloor. The CTD was always deployed from the side of the ship. Water samples were collected at specified depths, for a range of different purposes (microbiology, fluid, trace elements, total alkalinity, dissolved methane, trace elements, total mercury, mathylmercury and nutrients) (Table 1; Figure 3). In total we had 32 CTD stations (Figure 4).

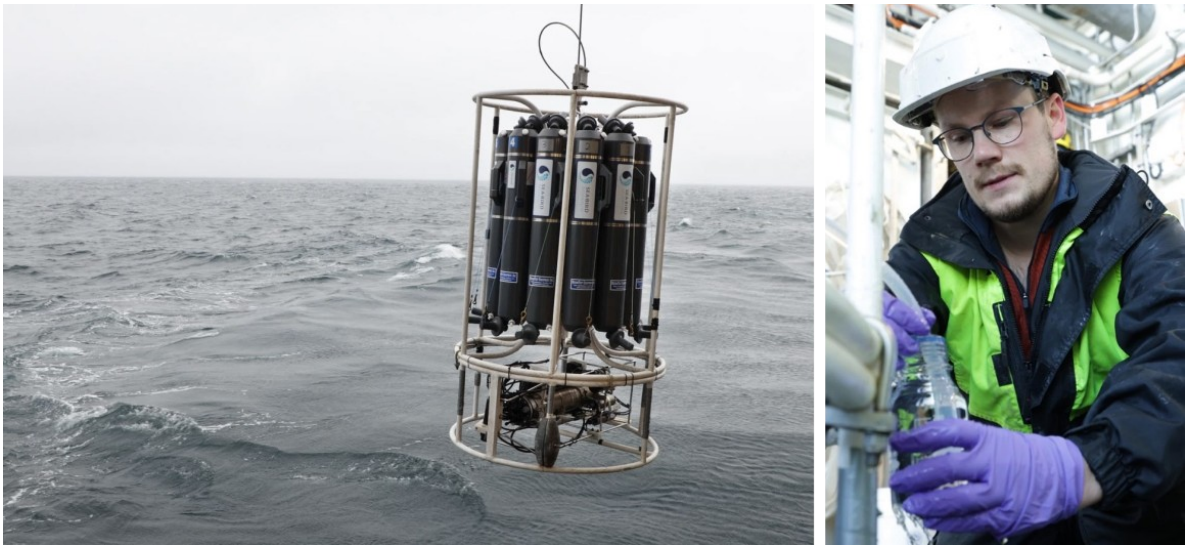


Figure 3: The CTD rosette with bottles being deployed (left). Sampling water from one of the Niskin bottles attached to the CTD rosette, after it is back on deck in the CTD hangar (Right). Photos by Daniel Albert, SINTEF / GoNorth.

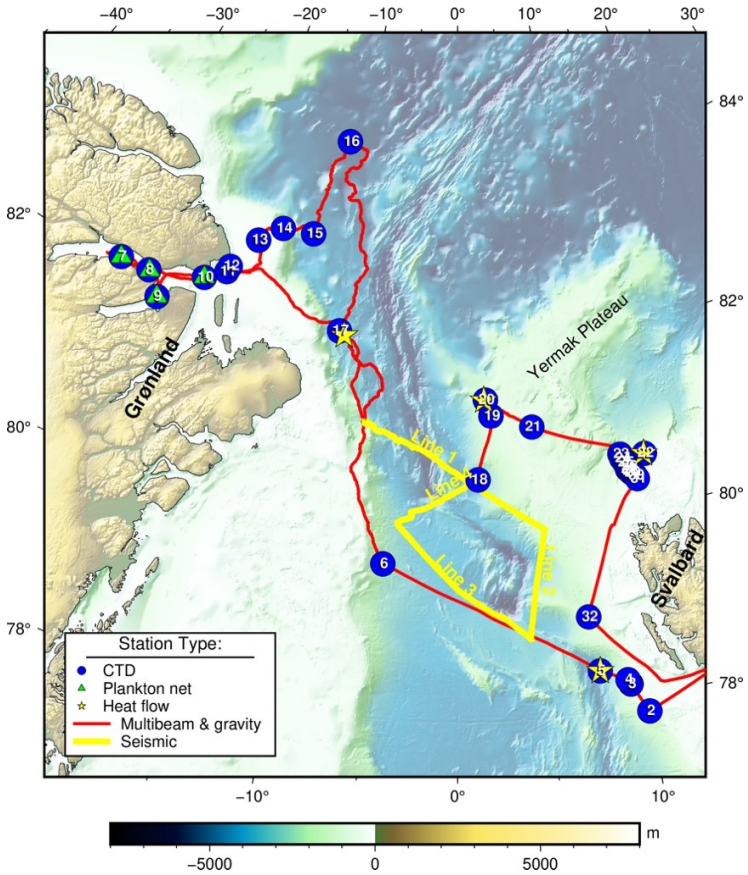


Figure 4: Overview of stations where CTDs (blue circles), plankton nets (green triangles) and heat flow measurements (stars) were done. The red line shows where multibeam, sub-bottom profiling and gravity measurements were done. The yellow line shows the seismic lines 1-4.

Table 3: Overview of CTD stations, with and without water samples. In stations where water samples were taken, the depth of the water sample, the Niskin bottle number that sea water was collected from, the type of analyses the water was collected for (i.e. purpose) and the PI of the collected samples are indicated.

Super station (KH14-259 station)	CTD station	Latitude (DDM)	Longitude (DDM)	Water depth (m)	Bottle no.	Purpose	PI
- (KH24-259-01)	251	78°16.23 N	15°30.49 E	104	-	-	-
1 (KH24-259-02)	252	77°50.04 N	09°58.81 E	398	1	Microbio Fluid	S. Jørgensen, UiB
2 (KH24-259-03)	253	78°09.05 N	09°14.53 E	699	1	Microbio Fluid	S. Jørgensen, UiB
3 (KH24-259-04)	254	78°11.88 N	09°6.39 E	924	1	Microbio Fluid	S. Jørgensen, UiB
4 (KH24-259-05)	255	78°20.861 N	07°43.088 E	2736	1	Microbio Fluid	S. Jørgensen, UiB
5 (KH24-259-06)	256	79°35.44 N	04°32. 23 W	1521	-	-	-
6 (KH24-259-07)	257	82°04.35 N	27°49.18 W	869 869 100 50 25 10 10 5	1 2 3 4 5 6 7 8	* Trace elem. * * * * Trace elem. *	M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT M. Winsborrow, UiT M. Winsborrow, UiT M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT

Super station (KH14-259 station)	CTD station	Latitude (DDM)	Longitude (DDM)	Water depth (m)	Bottle no.	Purpose	PI
7 (KH24-259-08)	258	82°04.63 N	25°23.42 W	625 625 100 50 25 10 10 5	1 2 3 4 5 6 7 8	* Trace elem. * * * Trace elem. * *	M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT M. Winsborrow, UiT M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT M. Winsborrow, UiT
8 (KH24-259-09)	259	81°50.85 N	23°56.31 W	465 465 100 50 25 10 10 5	1 2 3 4 5 6 7 8	* Trace elem. * * * Trace elem. * *	M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT M. Winsborrow, UiT M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT M. Winsborrow, UiT
9 (KH24-259-10)	260	82°14.46 N	21°03.08 W	530 530 100 50 25 10 10 5	1 2 3 4 5 6 7 8	* Trace elem. * * * * Trace elem. *	M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT M. Winsborrow, UiT M. Winsborrow, UiT M. Winsborrow, UiT B. Risebrobakken, NORCE M. Winsborrow, UiT
10 (KH24-259-11)	261	82°23.10 N	19°28.51W	506	-	-	-
11 (KH24-259-12)	262	82°27.25 N	19°21.61 W	455 10	1 2	Trace elem. Trace elem.	B. Risebrobakken, NORCE B. Risebrobakken, NORCE
12 (KH24-259-13)	263	82°49.70 N	17°46.63 W	367 10	1 2	Trace elem. Trace elem.	B. Risebrobakken, NORCE B. Risebrobakken, NORCE
13 (KH24-259-14)	264	83°01.58 N	15°59.69 W	1151	-	-	-
14 (KH24-259-15)	265	83°03.480 N	13°07.350 W	3276	-	-	-
15 (KH24-259-16)	266	84°08.27 N	11°43.28 W	50 300 1300 4017	1 2 3 4	Trace elem. Trace elem. Trace elem. Trace elem.	B. Risebrobakken, NORCE B. Risebrobakken, NORCE B. Risebrobakken, NORCE B. Risebrobakken, NORCE
16 (KH24-259-17)	267	83°03.816 N	09°26.165 W	2786	-	-	-
17 (KH24-259-18)	268	80°32.306 N	12°4.582 E	2840	-	-	-
18 (KH24-259-19)	269	81°13.923 N	02°23.039 E	1009	-	-	-
19 (KH24-259-20)	270	81°24.480 N	02°01.577 E	1109	-	-	-
20 (KH24-259-21)	271	81°04.854 N	05°14.467 E	653	-	-	-
21 (KH24-259-22)	272	80°36.299 N	12°36.612 E	1033	-	-	-
22 (KH24-259-23)	273	80°38.956 N	10°59.622 E	1143	-	-	-
23 (KH24-259-24)	274	80°36.082 N	11°03.426 E	1031	-	-	-
24 (KH24-259-25)	275	80°32.980 N	11°12.168 E	903	-	-	-
25 (KH24-259-26)	276	80°29.973 N	11°21.589 E	771	-	-	-
25 (KH24-259-27)	277	80°28.321 N	11°17.947 E	699	-	-	-
25 (KH24-259-28)	278	80°26.99 N	22°23.98 E	607	-	-	-

Super station (KH14-259 station)	CTD station	Latitude (DDM)	Longitude (DDM)	Water depth (m)	Bottle no.	Purpose	PI
25 (KH24-259-29)	279	80°25.50 N	11°30.06 E	504	-	-	-
26 (KH24-259-30)	280	80°23.38 N	11°41.84 E	283	-	-	-
27 (KH24-259-31)	281	80°21.02 N	11°47.89 E	193	-	-	-
28 (KH24-259-32)	282	78°56.91 N	07°28.39 E	1201	-	-	-

* Total alkalinity, dissolved methane, trace elements, total mercury, methylmercury, and nutrients.

4.3 Sediment coring

Sediment coring was done at 26 stations, using multi- and gravity-coring systems. At each station a multibeam and sub-bottom profile were done in advance of coring. Either at arrival or by passing by a selected site at an earlier stage.

4.3.1. Multi coring

The multicorer (MC) is used to sample undisturbed sediments from the upper ca 40 cm of the sediment package deposited at the ocean floor (Figure 5). We have used two different MCs, one which may take up to 4 cores and one which may take up to 6 cores at the same time. The 4-core one is the MC from the University of Bergen, while the 6-core one is from UiT. The 6-core MC has a camera attached, making it possible to film the sea bottom where the corer is deployed. Both corers have been used, optimising the operations and adjusting to the conditions at the individual sites.

A MC contains multiple core tubes. It is lowered down until it reaches the sea floor. When it hits the sea floor the tubes are pushed into the sediments due to the weight of the device. The weight is adjusted depending on the expected conditions at the sea floor. When it is retrieved from the bottom, the flaps are closed under the tubes to secure that the sediments do not fall out. Lids close the top of the tubes, preserving the sediment water interface while the MC is lifted from the ocean bottom to the ship (Figure 5).

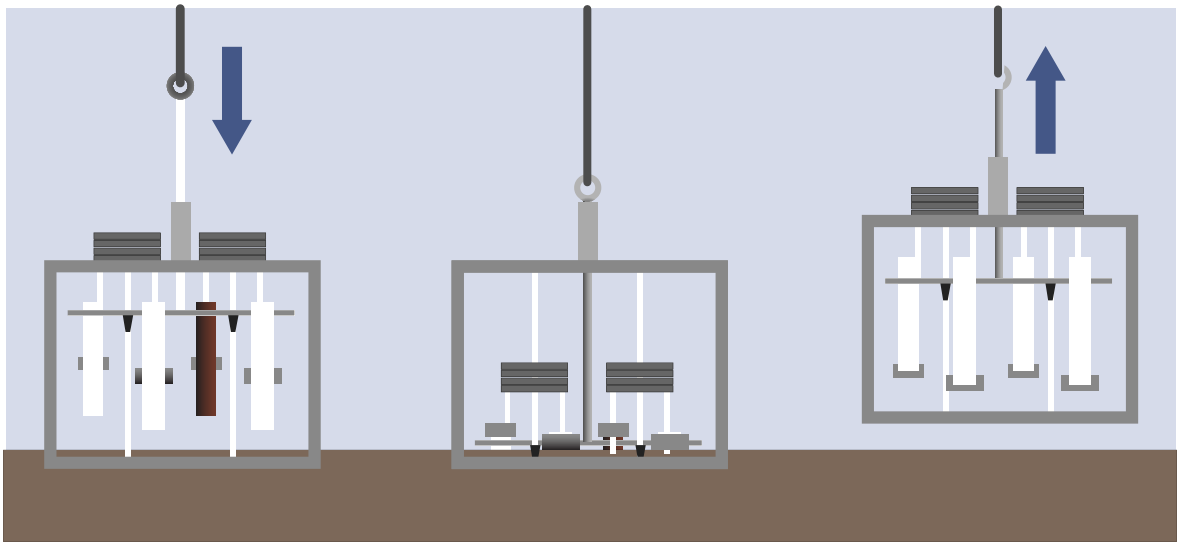


Figure 5: Ilustration showing the multicorer (MC) sampling function. See main text for description. Illustration by Daniel Albert, SINTEF /GoNorth

During the GoNorth 2024 cruise, 38 MC casts were performed, 31 with the UiB corer, 7 with the UiT corer. In total, 122 cores were recovered from a total of 26 stations (Figure 6; Table 4).

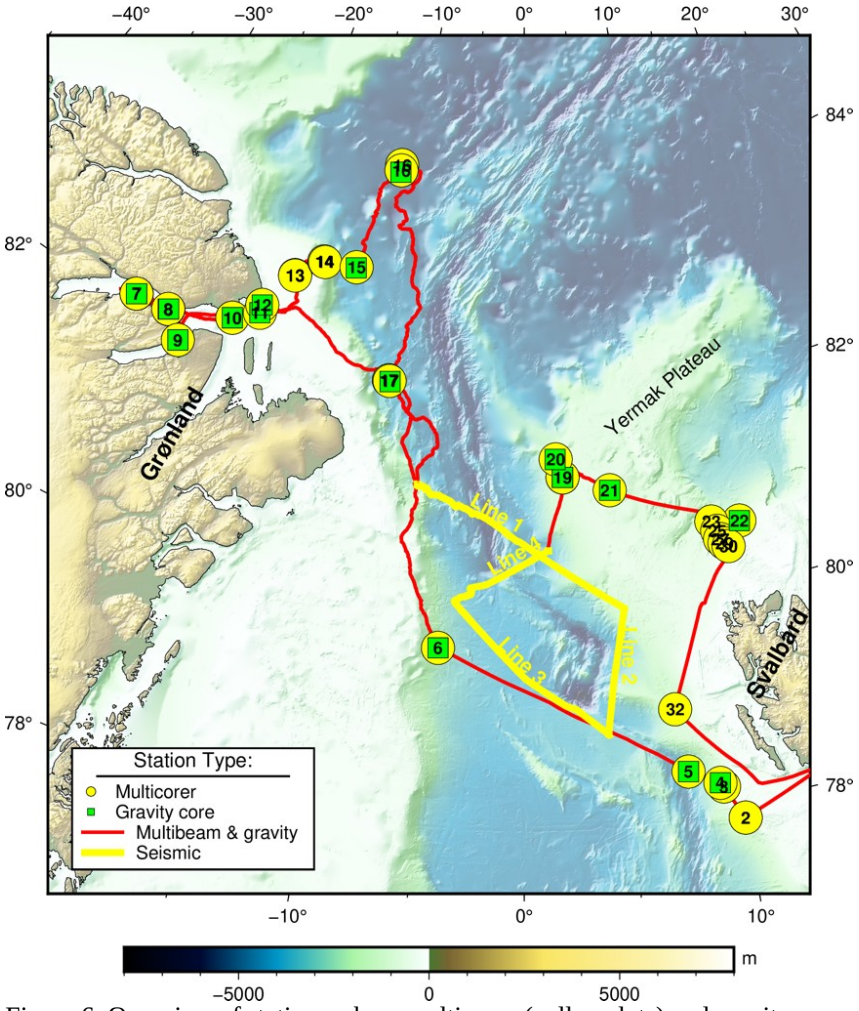


Figure 6: Overview of stations where multicores (yellow dots) and gravity cores (green squares) were recovered. The red line shows where multibeam, sub-bottom profiling and gravity measurements were done. The yellow line shows the seismic lines 1-4.

Table 4: Overview of collected MC cores, with and without recovery. Cores without any sediment recovery are marked as "empty".

Date (dd.mm)	Super station	Core name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	MC from	PI of the core
31.08	1	KH24-259-02-MC1-A	77°50.050 N	09°58.807 E	398	UiB	S. Jørgensen, UiB
31.08	1	KH24-259-02-MC1-B	77°50.050 N	09°58.807 E	398	UiB	S. Jørgensen, UiB
31.08	1	KH24-259-02-MC1-C	77°50.050 N	09°58.807 E	398	UiB	"empty"
31.08	1	KH24-259-02-MC1-D	77°50.050 N	09°58.807 E	398	UiB	"empty"
31.08	1	KH24-259-02-MC2-E	77°50.050 N	09°58.807 E	398	UiB	S. Jørgensen, UiB
31.08	1	KH24-259-02-MC2-F	77°50.050 N	09°58.807 E	398	UiB	"empty"
31.08	1	KH24-259-02-MC2-G	77°50.050 N	09°58.807 E	398	UiB	"empty"
31.08	1	KH24-259-02-MC2-H	77°50.050 N	09°58.807 E	398	UiB	"empty"
31.08	2	KH24-259-03-MC1-A	78°09.050 N	09°14.536 E	709	UiB	S. Jørgensen, UiB
31.08	2	KH24-259-03-MC1-B	78°09.050 N	09°14.536 E	709	UiB	S. Jørgensen, UiB
31.08	2	KH24-259-03-MC1-C	78°09.050 N	09°14.536 E	709	UiB	S. Jørgensen, UiB
31.08	2	KH24-259-03-MC1-D	78°09.050 N	09°14.536 E	709	UiB	S. Jørgensen, UiB
31.08	3	KH24-259-04-MC1-A	78°11.880 N	09°06.388 E	931	UiB	S. Jørgensen, UiB
31.08	3	KH24-259-04-MC1-B	78°11.880 N	09°06.388 E	931	UiB	S. Jørgensen, UiB

Date (dd.mm)	Super station	Core name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	MC from	PI of the core
31.08	3	KH24-259-04-MC1-C	78°11.880 N	09°06.388 E	931	UiB	S. Jørgensen, UiB
31.08	3	KH24-259-04-MC1-D	78°11.880 N	09°06.388 E	931	UiB	S. Jørgensen, UiB
31.08	4	KH24-259-05-MC1-A	78°20.861 N	07°43.088 E	2696	UiB	S. Jørgensen, UiB
31.08	4	KH24-259-05-MC1-B	78°20.861 N	07°43.088 E	2696	UiB	S. Jørgensen, UiB
31.08	4	KH24-259-05-MC1-C	78°20.861 N	07°43.088 E	2696	UiB	S. Jørgensen, UiB
31.08	4	KH24-259-05-MC1-D	78°20.861 N	07°43.088 E	2696	UiB	S. Jørgensen, UiB
01.09	5	KH24-259-06-MC1-A	79°35.452 N	04°32.238 W	1520	UiB	S. De Schepper, NORCE
01.09	5	KH24-259-06-MC1-B	79°35.452 N	04°32.238 W	1520	UiB	S. De Schepper, NORCE
01.09	5	KH24-259-06-MC1-C	79°35.452 N	04°32.238 W	1520	UiB	S. De Schepper, NORCE
01.09	5	KH24-259-06-MC1-D	79°35.452 N	04°32.238 W	1520	UiB	J. Knies, UiT/NGU
04.09	6	KH24-259-07-MC1-A	82°04.347 N	27°49.208 W	865	UiB	B. Risebrobakken, NORCE
04.09	6	KH24-259-07-MC1-B	82°04.347 N	27°49.208 W	865	UiB	M. Winsborrow, UiT
04.09	6	KH24-259-07-MC1-C	82°04.347 N	27°49.208 W	865	UiB	M. Winsborrow, UiT
04.09	6	KH24-259-07-MC1-D	82°04.347 N	27°49.208 W	865	UiB	“empty”
04.09	6	KH24-259-07-MC2-E	82°04.356 N	27°49.782 W	862	UiT*	“empty”
04.09	6	KH24-259-07-MC2-F	82°04.356 N	27°49.782 W	862	UiT*	“empty”
04.09	6	KH24-259-07-MC2-G	82°04.356 N	27°49.782 W	862	UiT*	“empty”
04.09	6	KH24-259-07-MC2-H	82°04.356 N	27°49.782 W	862	UiT*	“empty”
04.09	6	KH24-259-07-MC2-I	82°04.356 N	27°49.782 W	862	UiT*	“empty”
04.09	6	KH24-259-07-MC2-J	82°04.356 N	27°49.782 W	862	UiT*	“empty”
04.09	6	KH24-259-07-MC3-K	82°04.360 N	27°50.104 W	860	UiB	A. Weiner, NORCE
04.09	6	KH24-259-07-MC3-L	82°04.360 N	27°50.104 W	860	UiB	“empty”
04.09	6	KH24-259-07-MC3-M	82°04.360 N	27°50.104 W	860	UiB	“empty”
04.09	6	KH24-259-07-MC3-N	82°04.360 N	27°50.104 W	860	UiB	“empty”
04.09	6	KH24-259-07-MC4-O	82°04.362 N	27°50.109 W	863	UiB	“empty”
04.09	6	KH24-259-07-MC4-P	82°04.362 N	27°50.109 W	863	UiB	“empty”
04.09	6	KH24-259-07-MC4-Q	82°04.362 N	27°50.109 W	863	UiB	“empty”
04.09	6	KH24-259-07-MC4-R	82°04.362 N	27°50.109 W	863	UiB	“empty”
04.09	6	KH24-259-07-MC5-S	82°04.343 N	27°50.051 W	863	UiB	B. Risebrobakken, NORCE
04.09	6	KH24-259-07-MC5-T	82°04.343 N	27°50.051 W	863	UiB	A. Weiner, NORCE
04.09	6	KH24-259-07-MC5-U	82°04.343 N	27°50.051 W	863	UiB	M. Winsborrow, UiT
04.09	6	KH24-259-07-MC5-V	82°04.343 N	27°50.051 W	863	UiB	M. Winsborrow, UiT
05.09	7	KH24-259-08-MC1-A	82°04.597 N	25°24.062 W	625	UiB	B. Risebrobakken, NORCE
05.09	7	KH24-259-08-MC1-B	82°04.597 N	25°24.062 W	625	UiB	B. Risebrobakken, NORCE
05.09	7	KH24-259-08-MC1-C	82°04.597 N	25°24.062 W	625	UiB	A. Weiner, NORCE
05.09	7	KH24-259-08-MC1-D	82°04.597 N	25°24.062 W	625	UiB	A. Weiner, NORCE
05.09	7	KH24-259-08-MC2-E	82°04.627 N	25°23.837 W	623	UiB	M. Winsborrow, UiT
05.09	7	KH24-259-08-MC2-F	82°04.627 N	25°23.837 W	623	UiB	M. Winsborrow, UiT
05.09	7	KH24-259-08-MC2-G	82°04.627 N	25°23.837 W	623	UiB	M. Winsborrow, UiT
05.09	7	KH24-259-08-MC2-H	82°04.627 N	25°23.837 W	623	UiB	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC1-A	81°50.849 N	23°56.216 W	470	UiB	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC1-B	81°50.849 N	23°56.216 W	470	UiB	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC1-C	81°50.849 N	23°56.216 W	470	UiB	B. Risebrobakken, NORCE
05.09	8	KH24-259-09-MC1-D	81°50.849 N	23°56.216 W	470	UiB	A. Weiner, NORCE
05.09	8	KH24-259-09-MC2-E	81°50.866 N	23°56.223 W	472	UiT*	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC2-F	81°50.866 N	23°56.223 W	472	UiT*	B. Risebrobakken, NORCE
05.09	8	KH24-259-09-MC2-G	81°50.866 N	23°56.223 W	472	UiT*	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC2-H	81°50.866 N	23°56.223 W	472	UiT*	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC2-I	81°50.866 N	23°56.223 W	472	UiT*	M. Winsborrow, UiT
05.09	8	KH24-259-09-MC2-J	81°50.866 N	23°56.223 W	472	UiT*	A. Weiner, NORCE
06.09	9	KH24-259-10-MC1-A	82°14.475 N	21°03.039 W	532	UiB	A. Weiner, NORCE
06.09	9	KH24-259-10-MC1-B	82°14.475 N	21°03.039 W	532	UiB	A. Weiner, NORCE
06.09	9	KH24-259-10-MC1-C	82°14.475 N	21°03.039 W	532	UiB	B. Risebrobakken, NORCE
06.09	9	KH24-259-10-MC1-D	82°14.475 N	21°03.039 W	532	UiB	B. Risebrobakken, NORCE
06.09	9	KH24-259-10-MC2-E	82°14.479 N	21°03.084 W	533	UiB	M. Winsborrow, UiT
06.09	9	KH24-259-10-MC2-F	82°14.479 N	21°03.084 W	533	UiB	M. Winsborrow, UiT
06.09	9	KH24-259-10-MC2-G	82°14.479 N	21°03.084 W	533	UiB	M. Winsborrow, UiT
06.09	9	KH24-259-10-MC2-H	82°14.479 N	21°03.084 W	533	UiB	M. Winsborrow, UiT
06.09	10	KH24-259-11-MC1-A	82°22.590 N	19°20.098 W	538	UiB	R. Nomets, UNIS
0609	10	KH24-259-11-MC1-B	82°22.590 N	19°20.098 W	538	UiB	R. Nomets, UNIS

Date (dd.mm)	Super station	Core name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	MC from	PI of the core
06.09	10	KH24-259-11-MC1-C	82°22.590 N	19°20.098 W	538	UiB	M. Winsborrow, UiT
06.09	10	KH24-259-11-MC1-D	82°22.590 N	19°20.098 W	538	UiB	B. Risebrobakken, NORCE
06.09	11	KH24-259-12-MC1-A	82°27.261 N	19°21.635 W	462	UiT*	R. Nomets, UNIS
06.09	11	KH24-259-12-MC1-B	82°27.261 N	19°21.635 W	462	UiT*	R. Nomets, UNIS
06.09	11	KH24-259-12-MC1-C	82°27.261 N	19°21.635 W	462	UiT*	R. Nomets, UNIS
06.09	11	KH24-259-12-MC1-D	82°27.261 N	19°21.635 W	462	UiT*	“empty”
06.09	11	KH24-259-12-MC2-E	82°27.261 N	19°21.635 W	462	UiT*	“empty”
06.09	11	KH24-259-12-MC2-F	82°27.261 N	19°21.635 W	462	UiT*	“empty”
07.09	12	KH24-259-13-MC1-A	82°49.580 N	17°46.155 W	371	UiB	M. Winsborrow, UiT
07.09	12	KH24-259-13-MC1-B	82°49.580 N	17°46.155 W	371	UiB	B. Risebrobakken, NORCE
07.09	12	KH24-259-13-MC1-C	82°49.580 N	17°46.155 W	371	UiB	R. Nomets, UNIS
07.09	12	KH24-259-13-MC1-D	82°49.580 N	17°46.155 W	371	UiB	“empty”
07.09	12	KH24-259-13-MC2-E	82°49.290 N	17°45.171W	374	UiB	R. Nomets, UNIS
07.09	12	KH24-259-13-MC2-F	82°49.290 N	17°45.171W	374	UiB	A. Weiner, NORCE
07.09	12	KH24-259-13-MC2-G	82°49.290 N	17°45.171W	374	UiB	M. Winsborrow, UiT
07.09	12	KH24-259-13-MC2-H	82°49.290 N	17°45.171W	374	UiB	R. Nomets, UNIS
07.09	13	KH24-259-14-MC1-A	83°01.612 N	15°58.028 W	1231	UiB	“empty”
07.09	13	KH24-259-14-MC1-B	83°01.612 N	15°58.028 W	1231	UiB	“empty”
07.09	13	KH24-259-14-MC1-C	83°01.612 N	15°58.028 W	1231	UiB	“empty”
07.09	13	KH24-259-14-MC1-D	83°01.612 N	15°58.028 W	1231	UiB	“empty”
07.09	13	KH24-259-14-MC2-E	83°01.654 N	15°53.011 W	1473	UiT*	“empty”
07.09	13	KH24-259-14-MC2-F	83°01.654 N	15°53.011 W	1473	UiT*	“empty”
07.09	13	KH24-259-14-MC2-G	83°01.654 N	15°53.011 W	1473	UiT*	“empty”
07.09	13	KH24-259-14-MC2-H	83°01.654 N	15°53.011 W	1473	UiT*	“empty”
0709	13	KH24-259-14-MC2-I	83°01.654 N	15°53.011 W	1473	UiT*	“empty”
07.09	13	KH24-259-14-MC2-J	83°01.654 N	15°53.011 W	1473	UiT*	“empty”
08.09	14	KH24-259-15-MC1-A	83°03.184 N	13°12.294 W	3259	UiT*	S. De Schepper, NORCE
08.09	14	KH24-259-15-MC1-B	83°03.184 N	13°12.294 W	3259	UiT*	S. De Schepper, NORCE
08.09	14	KH24-259-15-MC1-C	83°03.184 N	13°12.294 W	3259	UiT*	S. De Schepper, NORCE
08.09	14	KH24-259-15-MC1-D	83°03.184 N	13°12.294 W	3259	UiT*	S. De Schepper, NORCE
08.09	14	KH24-259-15-MC2-E	83°03.184 N	13°12.294 W	3259	UiT*	“empty”
08.09	14	KH24-259-15-MC2-F	83°03.184 N	13°12.294 W	3259	UiT*	“empty”
09.09	15	KH24-259-16-MC1-A	84°07.575 N	11°35.335 W	3933	UiB	S. De Schepper, NORCE
09.09	15	KH24-259-16-MC1-B	84°07.575 N	11°35.335 W	3933	UiB	S. De Schepper, NORCE
09.09	15	KH24-259-16-MC1-C	84°07.575 N	11°35.335 W	3933	UiB	S. De Schepper, NORCE
09.09	15	KH24-259-16-MC1-D	84°07.575 N	11°35.335 W	3933	UiB	S. De Schepper, NORCE
09.09	15	KH24-259-16-MC2-E	84°07.575 N	11°35.335 W	3933	UiT*	B. Bloom, UiT
09.09	15	KH24-259-16-MC2-F	84°07.575 N	11°35.335 W	3933	UiT*	B. Bloom, UiT
09.09	15	KH24-259-16-MC2-G	84°07.575 N	11°35.335 W	3933	UiT*	B. Bloom, UiT
09.09	15	KH24-259-16-MC2-H	84°07.575 N	11°35.335 W	3933	UiT*	B. Bloom, UiT
09.09	15	KH24-259-16-MC2-I	84°07.575 N	11°35.335 W	3933	UiT*	“empty”
09.09	15	KH24-259-16-MC2-J	84°07.575 N	11°35.335 W	3933	UiT*	“empty”
10.09	16	KH24-259-17-MC1-A	82°03.785 N	09°25.898 W	2763	UiB	S. De Schepper, NORCE
10.09	16	KH24-259-17-MC1-B	82°03.785 N	09°25.898 W	2763	UiB	S. De Schepper, NORCE
10.09	16	KH24-259-17-MC1-C	82°03.785 N	09°25.898 W	2763	UiB	S. De Schepper, NORCE
10.09	16	KH24-259-17-MC1-D	82°03.785 N	09°25.898 W	2763	UiB	“empty”
10.09	16	KH24-259-17-MC2-E	82°03.500 N	09°22.103 W	2776	UiT*	J. Sverre Laberg, UiT
10.09	16	KH24-259-17-MC2-F	82°03.500 N	09°22.103 W	2776	UiT*	J. Sverre Laberg, UiT
10.09	16	KH24-259-17-MC2-G	82°03.500 N	09°22.103 W	2776	UiT*	J. Sverre Laberg, UiT
1009	16	KH24-259-17-MC2-H	82°03.500 N	09°22.103 W	2776	UiT*	J. Sverre Laberg, UiT
10.09	16	KH24-259-17-MC2-I	82°03.500 N	09°22.103 W	2776	UiT*	J. Sverre Laberg, UiT
10.09	16	KH24-259-17-MC2-J	82°03.500 N	09°22.103 W	2776	UiT*	“empty”
16.09	18	KH24-259-19-MC1-A	81°13.924 N	02°23.028 E	1014	UiB	S. De Schepper, NORCE
16.09	18	KH24-259-19-MC1-B	81°13.924 N	02°23.028 E	1014	UiB	S. De Schepper, NORCE
16.09	18	KH24-259-19-MC1-C	81°13.924 N	02°23.028 E	1014	UiB	S. De Schepper, NORCE
16.09	18	KH24-259-19-MC1-D	81°13.924 N	02°23.028 E	1014	UiB	J. Knies, UiT/NGU
16.09	18	KH24-259-19-MC2-E	81°13.924 N	02°23.028 E	1014	UiB	J. Sverre Laberg, UiT
16.09	18	KH24-259-19-MC2-F	81°13.924 N	02°23.028 E	1014	UiB	J. Sverre Laberg, UiT
16.09	18	KH24-259-19-MC2-G	81°13.924 N	02°23.028 E	1014	UiB	J. Sverre Laberg, UiT
16.09	18	KH24-259-19-MC2-H	81°13.924 N	02°23.028 E	1014	UiB	J. Sverre Laberg, UiT

Date (dd.mm)	Super station	Core name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	MC from	PI of the core
16.09	19	KH24-259-20-MC1-A	81°24.481 N	02°01.577 E	1103	UiB	R. Noormets, UNIS
16.09	19	KH24-259-20-MC1-B	81°24.481 N	02°01.577 E	1103	UiB	R. Noormets, UNIS
16.09	19	KH24-259-20-MC1-C	81°24.481 N	02°01.577 E	1103	UiB	R. Noormets, UNIS
16.09	19	KH24-259-20-MC1-D	81°24.481 N	02°01.577 E	1103	UiB	R. Noormets, UNIS
17.09	20	KH24-259-21-MC1-A	81°04.861 N	05°14.469 E	652	UiB	R. Noormets, UNIS
17.09	20	KH24-259-21-MC1-B	81°04.861 N	05°14.469 E	652	UiB	R. Noormets, UNIS
17.09	20	KH24-259-21-MC1-C	81°04.861 N	05°14.469 E	652	UiB	R. Noormets, UNIS
17.09	20	KH24-259-21-MC1-D	81°04.861 N	05°14.469 E	652	UiB	R. Noormets, UNIS
17.09	21	KH24-259-22-MC1-A	80°36.292 N	12°36.601 E	1033	UiB	S. De Schepper, NORCE
17.09	21	KH24-259-22-MC1-B	80°36.292 N	12°36.601 E	1033	UiB	S. De Schepper, NORCE
17.09	21	KH24-259-22-MC1-C	80°36.292 N	12°36.601 E	1033	UiB	S. De Schepper, NORCE
17.09	21	KH24-259-22-MC1-D	80°36.292 N	12°36.601 E	1033	UiB	J. Knies, UiT/NGU
17.09	22	KH24-259-23-MC1-A	80°38.999 N	10°59.997 E	1145	UiB	GoNorth*
17.09	22	KH24-259-23-MC1-B	80°38.999 N	10°59.997 E	1145	UiB	GoNorth*
1709	22	KH24-259-23-MC1-C	80°38.999 N	10°59.997 E	1145	UiB	GoNorth*
17.09	22	KH24-259-23-MC1-D	80°38.999 N	10°59.997 E	1145	UiB	GoNorth*
18.09	24	KH24-259-25-MC1-A	80°32.995 N	11°12.013 E	903	UiB	GoNorth*
18.09	24	KH24-259-25-MC1-B	80°32.995 N	11°12.013 E	903	UiB	GoNorth*
18.09	24	KH24-259-25-MC1-C	80°32.995 N	11°12.013 E	903	UiB	GoNorth*
18.09	24	KH24-259-25-MC1-D	80°32.995 N	11°12.013 E	903	UiB	GoNorth*
18.09	25	KH24-259-27-MC1-A	80°28.320 N	11°17.942 E	703	UiB	GoNorth*
18.09	25	KH24-259-27-MC1-B	80°28.320 N	11°17.942 E	703	UiB	GoNorth*
18.09	25	KH24-259-27-MC1-C	80°28.320 N	11°17.942 E	703	UiB	GoNorth*
18.09	25	KH24-259-27-MC1-D	80°28.320 N	11°17.942 E	703	UiB	GoNorth*
18.09	25	KH24-259-29-MC1-A	80°25.502 N	11°30.067 E	510	UiB	“empty”
18.09	25	KH24-259-29-MC1-B	80°25.502 N	11°30.067 E	510	UiB	“empty”
18.09	25	KH24-259-29-MC1-C	80°25.502 N	11°30.067 E	510	UiB	“empty”
18.09	25	KH24-259-29-MC1-D	80°25.502 N	11°30.067 E	510	UiB	“empty”
18.09	26	KH24-259-30-MC1-A	80°23.382 N	11°41.842 E	289	UiB	“empty”
18.09	26	KH24-259-30-MC1-B	80°23.382 N	11°41.842 E	289	UiB	“empty”
18.09	26	KH24-259-30-MC1-C	80°23.382N	11°41.842 E	289	UiB	“empty”
18.09	26	KH24-259-30-MC1-D	80°23.382 N	11°41.842 E	289	UiB	“empty”
19.09	26	KH24-259-32-MC1-A	78°56.910 N	07°28.390 E	1201	UiB	S. De Schepper, NORCE
19.09	28	KH24-259-32-MC1-B	78°56.910 N	07°28.390 E	1201	UiB	S. De Schepper, NORCE
19.09	28	KH24-259-32-MC1-C	78°56.910 N	07°28.390 E	1201	UiB	S. De Schepper, NORCE
19.09	28	KH24-259-32-MC1-D	78°56.910 N	07°28.390 E	1201	UiB	S. De Schepper, NORCE.

*Towards the end of the cruise, when we did see that we managed all planed sites and activities in good time, we seized the opportunity to do a CTD and MC transect crossing the branch of inflowing Atlantic Water that enters the Arctic Ocean through the Yermak Plateau. This material provides opportunities for future studies of natural, or recent historical, variability in this very sensitive region where the largest climatic changes presently take place. Activities of this material will be coordinated by the Cruise leaders, Bjørg Risebrobakken and Jan Sverre Laberg. Given proven access to funding and clear plans for deliverables, access to material may be made available to GoNorth partners upon request.

4.3.2. Gravity coring

The gravity corer (GC) is used to sample up to 6 m of the sediment package deposited at the sea floor (Figure 7). We have used two different GCs, one from the University of Bergen (max. 5 m), and one from UiT (max. 6 m). Both corers have been used, optimising the operations and adjusting to the conditions at the individual sites.

The GC is lowered down until it is just above the sea floor, before being lowered into the sediment. The weight added at the top of the corer pushes it into the sediment. When the corer is lifted back up, the sediment is captured in the corer due to the core catcher at the bottom of the coring device.



Figure 7: Upper left, core catcher, the part that ensures that the sediment is kept in the core. Upper right, a gravity corer (GC) ready to be deployed, with the core catcher secured at the bottom. Bottom left, deployment of the GC. Bottom right, retrieving the gravity core from the corer. Photos by Daniel Albert, SINTEF / GoNorth.

During the GoNorth 2024 cruise, 27 GC casts were performed, 16 with the UiB corer, 11 with the UiT corer. In total 26 gravity cores were recovered from a total of 18 stations (Table 5).

Table 5: Overview of collected gravity cores, with and without recovery. Cores without any sediment recovery are marked as “empty”.

Date (dd.mm)	Super station	Core name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	GC from	PI of the core
31.08	3	KH24-259-04-GC	78°11.879 N	09°06.418 E	932	UiB	S. Jørgensen, UiB
31.08	4	KH24-259-05-GC	78°20.861 N	07°43.092 E	2697	UiB	S. Jørgensen, UiB
01.09	5	KH24-259-06-GC1	79°35.452 N	04°32.239W	1520	UiB	J. Knies, UiT/NGU
01.09	5	KH24-259-06-GC2	79°35.452 N	04°32.239 W	1520	UiB	S. De Schepper, NORCE
04.09	6	KH24-259-07-GC1	82°04.349 N	27°49.035 W	865	UiT	M. Winsborrow, UiT
04.09	6	KH24-259-07-GC2	82°04.336 N	27°50.032 W	863	UiB	M. Winsborrow, UiT
04.09	6	KH24-259-07-GC3	82°04.336 N	27°50.032 W	863	UiB	B. Risebrobakken, NORCE
05.09	7	KH24-259-08-GC1	82°04.632 N	25°24.149 W	624	UiT	M. Winsborrow, UiT
05.09	7	KH24-259-08-GC2	82°04.698 N	25°23.803 W	629	UiB	M. Winsborrow, UiT
05.09	7	KH24-259-08-GC3	82°04.765 N	25°22.898 W	643	UiB	B. Risebrobakken, NORCE
05.09	8	KH24-259-09-GC1	81°50.881 N	23°56.182 W	474	UiT	M. Winsborrow, UiT
05.09	8	KH24-259-09-GC2	81°50.881 N	23°56.177 W	474	UiB	B. Risebrobakken, NORCE
06.09	9	KH24-259-10-GC1	82°14.481N	21°03.074 W	533	UiT	M. Winsborrow, UiT
06.09	9	KH24-259-10-GC2	82°14.483 N	21°03.089 W	534	UiB	B. Risebrobakken, NORCE
06.09	10	KH24-259-11-GC	82°22.597 N	19°20.102 W	538	UiB	R. Noormets, UNIS
07.09	11	KH24-259-12-GC	82°27.260 N	19°21.632 W	462	UiB	R. Noormets, UNIS
08.09	14	KH24-259-15-GC	83°03.040 N	13°20.155 W	3217	UiB	R. Noormets, UNIS
09.09	15	KH24-259-16-GC	84°02.351 N	11°22.438 W	3934	UiB	“empty” - GoNorth
10.09	16	KH24-259-17-GC	82°03.093 N	09°18.504 W	2776	UiB	J. Sverre Laberg, UiT
16.09	18	KH24-259-19-GC1	81°13.924 N	02°23.028 E	1014	UiT	J. Sverre Laberg, UiT
16.09	18	KH24-259-19-GC2	81°13.924 N	02°23.028 E	1014	UiB	J. Sverre Laberg, UiT
16.09	18	KH24-259-19-GC3	81°13.924 N	02°23.028 E	1014	UiT	J. Knies, UiT/NGU

Date (dd.mm)	Super station	Core name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	GC from	PI of the core
16.09	18	KH24-259-19-GC4	81°13.924 N	02°23.028 E	1014	UiT	S. De Schepper, NORCE
16.09	19	KH24-259-20-GC	81°24.481 N	02°01.577 E	1103	UiT	R. Noormets, UNIS
17.09	20	KH24-259-21-GC	81°04.863 N	05°14.491 E	653	UiT	R. Noormets, UNIS
17.09	21	KH24-259-22-GC1	80°36.296 N	12°36.598 E	1036	UiT	S. De Schepper, NORCE
17.09	21	KH24-259-22-GC2	80°36.296 N	12°36.597 E	1036	UiT	J. Knies, UiT/NGU

4.4 Plankton net

One plankton net tow 0−50 m, using a 10 µm net deployed from the CTD hangar at the side of the ship was done at four stations (Figure 4 and 8, Table 6). The plankton samples were preserved using a formalin solution before being refrigerated.

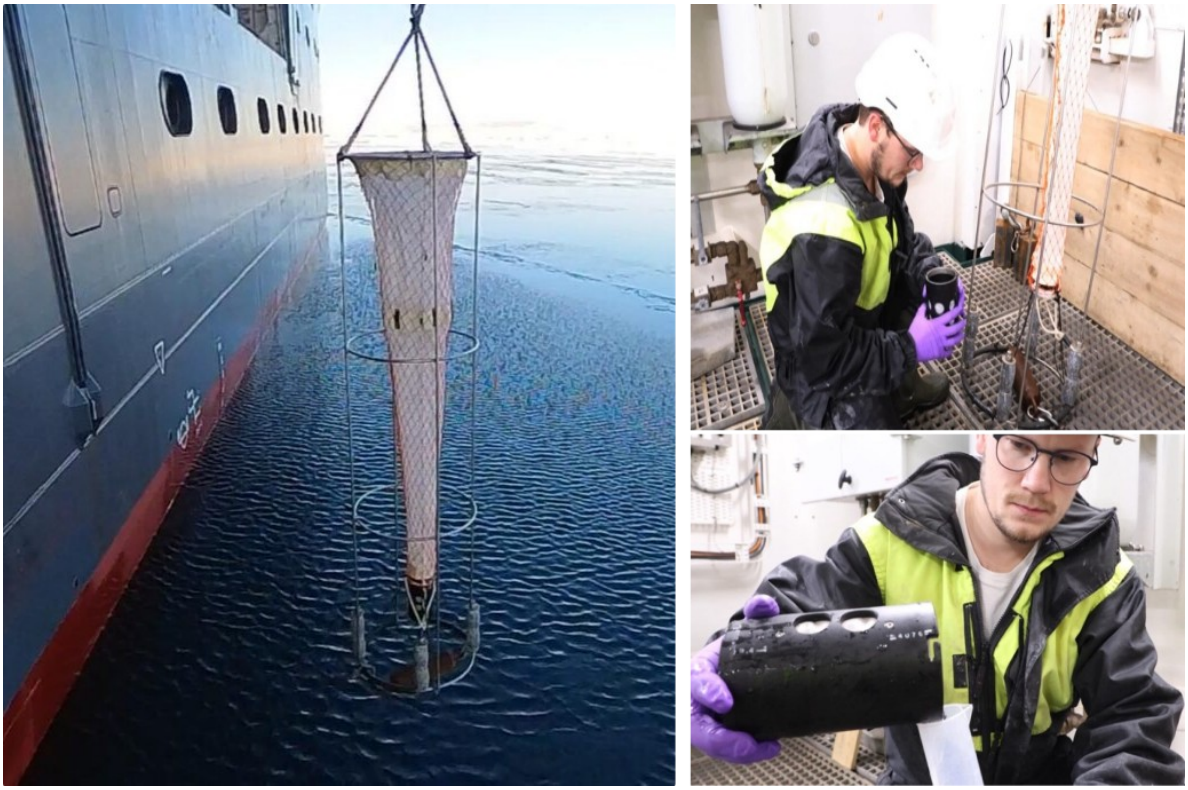


Figure 8: Sampling with plankton net. Photos by Daniel Albert, SINTEF /GoNorth.

Table 6: Overview of plankton net samples collected.

Date (dd.mm)	Super station	Station name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	PI of plankton net samples
04.09	6	KH24-259-07	82°04.347 N	27°49.177 W	0−50	M. Winsborrow, UiT
05.09	7	KH24-259-08	82°04.516 N	25°18.427 W	0−50	M. Winsborrow, UiT
05.09	8	KH24-259-09	81°50.848 N	23°56.216 W	0−50	M. Winsborrow, UiT
06.09	9	KH24-259-10	82°14.460 N	21°03.144 W	0−50	M. Winsborrow, UiT

4.5 Heat flow measurements

A CTM-1030 heat flow probe, equipped with 22 high sensitivity sensors which can record minimal temperature variations in sediments, was used (Figure 9). Prior to deployment, the probe was tested with a 12-V power supply to check that it was working correctly and to export the data. A stick with a magnet attached on the end acted as a start/stop tool for the probe.

Holding the magnet close to a switch activates a red light, indicating that the probe has been turned on. Repeating this manoeuvre turns the probe back off. When mounting the probe, the contacts on the three cables were smeared with silicon to prevent seawater from damaging the connections. A power unit and the probe were mounted into a weight stand which was attached to a 6-m long sensor string. To limit the use of power, the probe was calibrated to start measuring when below a specified depth, defined by the depth of the station. Due to technical issues, only sediment temperature was measured, but not conductivity. The data collected was processed using the software SST Standard Data Acquisition rev. 2.18. The heat flow probe was used at four stations (Figure 4 and Table 7).

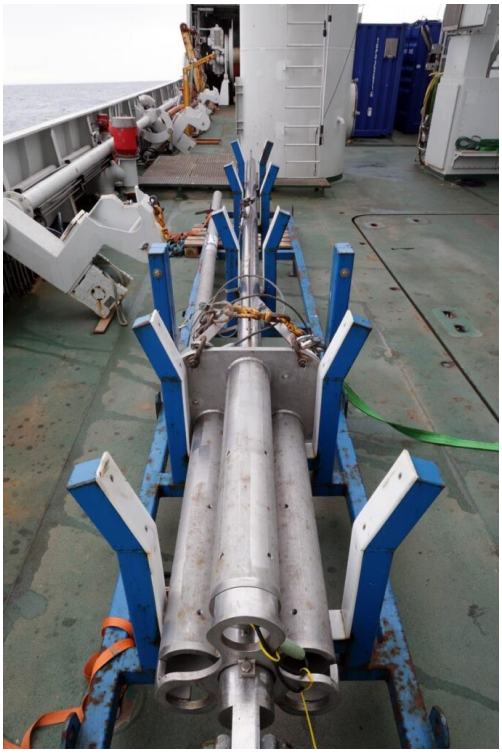


Figure 9: The active part of the heat flow probe is 6-m long, with a temperature sensor every 26 cm. A battery and a data recorder are located in the upper part of the probe. The probe measures temperature with a high sensitivity. The probe may also project heat pulses into the sediment. The heat pulses are sent out to obtain a measure on how well the sediment lead heat. Photo by Daniel Albert, SINTEF / GoNorth.

Table 7: Overview of heat flow probe measurements performed during the cruise.

Date (dd.mm)	Super station	Station name	Latitude (DDM)	Longitude (DDM)	Water depth (m)	PI of heat flow probe measurement
01.09	4	KH24-259-05	78°20.860 N	07°43.094 E	2696	S. Bünz, UiT
11.09	16	KH24-259-17	82°02.351 N	09°08.830 W	2776	S. Bünz, UiT
16.09	19	KH24-259-20	81°24.481 N	02°01.577 E	1103	S. Bünz, UiT
17.09	21	KH24-259-22	80°36.326 N	12°36.910 E	1037	S. Bünz, UiT

4.6 Gravimetry

The sea gravimeter, a LaCost & Romberg dynamic gravity meter (provided by UiB), was positioned in a dedicated room near the ship's centre of mass, directly below the GPS antenna. This location minimises the effects of ship motion on the gravity measurements. The gravity meter system comprises a gyro-stabilised platform and a dynamic control system to ensure accurate readings in the marine environment. The gravimeter was run continuously throughout the entire cruise (Figure 1).

Data acquisition and control are managed by the UltraSys software running on a dedicated PC. The system continuously logs gravity data at 10-s intervals, providing high temporal resolution. Additionally, filtered digital gravity data is transmitted via a serial connection to the Eiva NaviPac PC, where it is incorporated into the event log during seismic line acquisition, allowing for precise correlation between gravity, magnetic, bathymetry and seismic data.

To convert the relative gravity measurements to absolute values, the system requires calibration to a known gravity point. For this expedition, a reference point at the Longyearbyen harbour, established during previous cruises, serves as the absolute gravity benchmark. A land gravimeter is used to measure the gravity difference between a point near the ship's berth and this known reference point at the beginning and end of the cruise. This procedure allows for the correction of any drift in the sea gravimeter over the course of the expedition.

Preliminary processing of gravity data included: correction of relative gravity meters readings using measurements at the reference points in Longyearbyen, subtraction of normal gravity field computed for the WGS84 model, and Eötvös correction. The comparison of the obtained free-air gravity anomaly with the regional dataset (DTU grid) shows a good match (Figure 10). However, our measurements are characterized by a significantly better resolution.

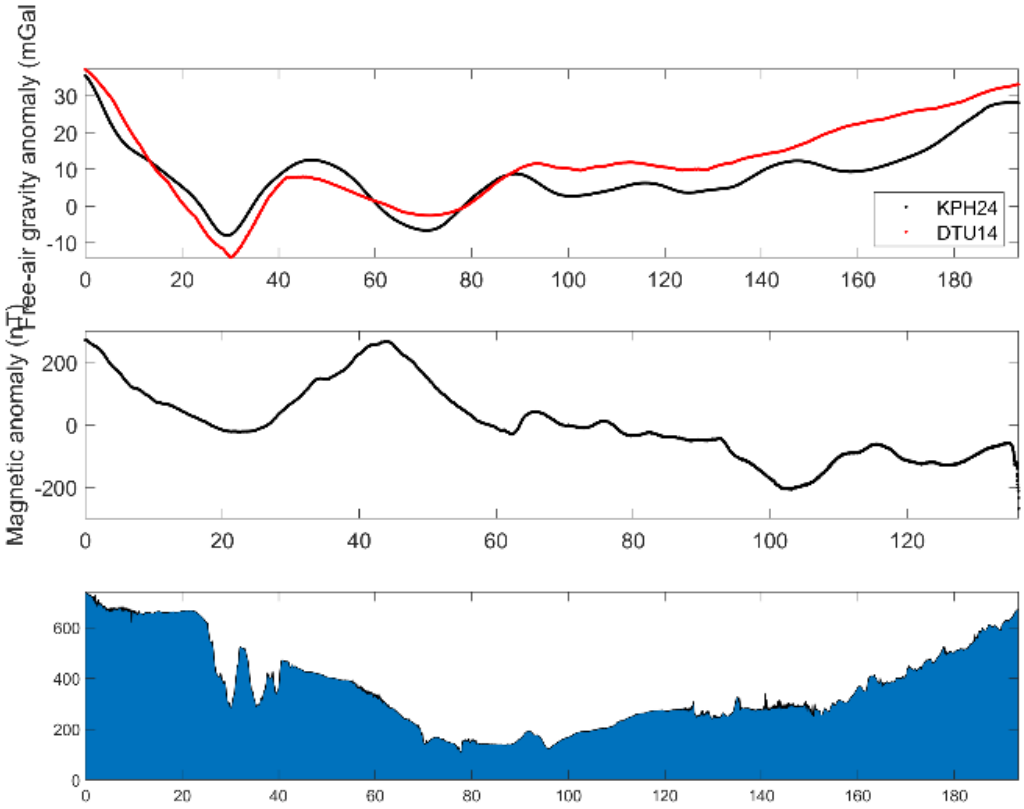


Figure 10: Gravity and magnetic data example collected along seismic Line 3, oriented E - W (see also Table 8 and Figure 12).

4.7 Bathymetry/water column data

Bathymetric and water column data were acquired by the Kongsberg EM302 multibeam echosounder that is flush-mounted underneath the ship. The EM302 multibeam echo sounder (30 kHz) is designed to perform seabed mapping with high resolution and accuracy to a maximum depth of more than 7000 m. Swath width is 5.5 x depth, to more than 8 km. The system has focused beams for transmission and reception, up to 864 soundings per ping, and yaw, pitch and roll compensation and stabilisation. It also includes seabed image (sidescan) data display and recording, and water column data display and recording. EM 302 is also equipped with a function to reduce the transmission power in order to avoid hurting mammals if they are close by.

The alternative system, the Kongsberg EM710 MKII was not employed during this expedition as the sonar array is installed on a drop keel that cannot be used in ice-infested waters.

Data were acquired continuously throughout the cruise but not within 12 nautical miles distance of Svalbard. The acquisition was monitored by the ship's instrument technicians. However, during the mapping in the northern area between the Gakkel Ridge and Morris Jesup Rise, the monitoring was done by the science party with watch standers from GEUS, AU, UNIS, and GST.

4.7.1. Patch test of multibeam echosounder Kongsberg EM302

Prior to leaving Longyearbyen, a multibeam echosounder (MBES) patch test was conducted in a restricted area within Adventfjorden on August 30, 2024. Instructions from the hydrographic survey (permission by Kartverket ref. 23/10578-2) were followed. The patch test was conducted to determine misalignments between installed attitude (roll, pitch, heading, heave), positioning sensors and the MBES arrays. Patch testing is considered best practice in cases where bathymetry is one of the main objectives. Regardless how accurate the equipment has performed in the past, there will always be minor adjustments to account for. The patch test found expected minor misalignments (<1° on roll, pitch and yaw, and no latency) that will be accounted for in the post-processing.

4.7.2. Acquisition software, parameters and auxiliary sensors

The Seafloor Information System (SIS) v. 4.3.2 was utilised to control the settings of the Kongsberg EM302, the runtime parameters, and data logging. The synchronisation system K-sync was used to synchronise the triggering of the hydro-acoustic instruments onboard to avoid interference between them. Hereby, the Kongsberg EM302 functioned as the master trigger. In addition, the Build-In Self Test (BIST) was conducted on August 30 and September 11, 2024; both times without any detected issues.

Table 6 specifies the runtime parameters of the Kongsberg EM302 system used during the expedition.

Table 8: Kongsberg EM302 runtime parameters. During the expedition, some parameters were changed based on depth and conditions.

Parameter	Setting
Max. angle (deg)	65 port side and starboard
Max. coverage (m)	4000 port side and starboard
Angular coverage mode	AUTO
Beam spacing	HD EQDST
Dual swath mode	DYNAMIC
Ping mode	AUTO
Pitch stabilisation	Tick ON
Sound speed at transducer	SENSOR
Spike filter strength	SENSOR (during ice breaking)
Range gate	NORMAL
Phase ramp	NORMAL
Penetration filter strength	OFF
Slope	Tick ON
Aeration	Tick ON
Sector tracking	Tick ON
Interference	Tick ON
Backscatter adjustment, normal incidence corr. (deg)	5
Use Lambert’s law	Tick ON
Water column	30 log R, 20 dB Offset
Real time data cleaning	None

Kongsberg Seapath 330-5 provided real-time heading, attitude, position and velocity measurements. Seapath 300-5 received positioning corrections, Precise Point Positioning (PPP), which reduces the uncertainty to sub-decimetre level. Fugro Spotbeam G2 (GPS and Glonass) served as the correction provider via internet. Several times during the acquisition, the Kongsberg Seapath lost connection to Fugro Spotbeam G2. This was fixed by a manual restart of the PPP receiver located on the bridge, thus increasing the positioning uncertainty for short periods (up to a few metres uncertainty).

4.7.3. Sound speed

Knowing the speed of sound through the water column is essential to account for sound refraction. Every time a CTD was obtained, a sound velocity profile was calculated based on salinity, temperature and pressure, and imported into SIS. In addition, a sound velocity sensor at the EM302 transducer (Valeport miniSVS) was prioritised in SIS to support beam forming. However, the number of sound velocity profile was not sufficient for the large area covered, which results in some artefacts in the measurements. Expendable bathythermographs (XBT) or moving velocity profilers (MVP) should be considered for the future to reduce sound speed-related issues in ice-free conditions.

4.7.4. Underway data processing

Bathymetric data were processed during the expedition using QPS Qimera v2.6.3. Sound velocity profiles were analysed, processed, and managed in the open-source application Sound Speed Manager v2024.1.2.

Data processing workflow was as following:

Add raw sonar files: Add .all files, assign the correct vessel file and ticking on the *verify NMEA checksum*. The coordinate system of the imported data was WGS 84 (EPSG: 4326).

Processing Settings Editor: *The Sound Velocity Strategy* was changed to *Nearest in distance* due to the high variability and changes in fjords and open sea.

Vessel Editor: Patch test values were added to new raw sonar files.

Auto process: Each time changes to the settings are made, Qimera requires an *auto process* to ray trace bathymetry and adjust offsets. Processed point files (*.QPD)* are also created during the auto process. Afterwards, data were appended to the dynamic grid.

Time Series Editor: Attitude and navigation data were checked for blunders.

Data Cleaning: The point cloud was reviewed prior to the application of a spline filter to eliminate gross outliers. Due to ice breaking and other noise input, manual cleaning was applied using a combination of Swath Editor, Slice Editor, and 3D Editor depending on the complexity of the seabed morphology. Water column data were frequently used to identify outliers.

Examples of acquired data are shown in Figure 11.

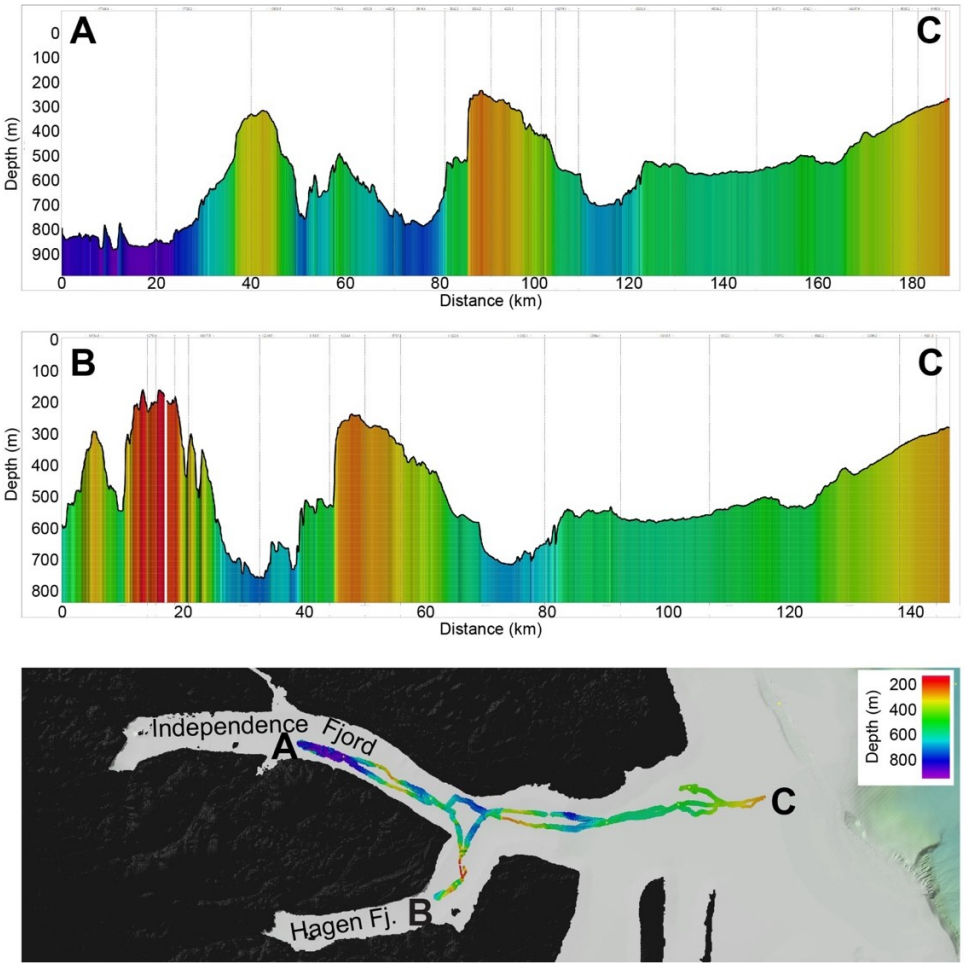


Figure 11: Depth profile along Independence Fjord (top). Depth profile from Hagen Fjord to the mouth of Independence Fjord (centre). Location of the two depth profiles displayed together with the bathymetry along the ship's track (bottom).

4.8 Seismic

The GoNorth 2024 expedition successfully acquired four 2D multi-channel seismic (MCS) profiles with a total length of 724 km. The new data offer valuable insight into the sedimentary and tectonic structure of the Fram Strait, the Lena Trough, and continental margins of Norway (Svalbard) and Greenland (Figure 12; Table 9).

Line 1 runs across the southern Lena Trough following the seafloor spreading direction. Line 2 is runs in north-south direction and connects Site 912 of the Ocean Drilling Program (ODP) Leg 151 with the recent wells VRW02-03 from the International Ocean Discovery Program (IODP) Expedition 403. Line 3 extends across the Molloy Deep toward the Northeast Greenland continental margin, while Line 4 runs from Northeast Greenland progradational wedge towards the southwestern margin of the Yermak Plateau.

The MCS reflection system utilised for this expedition was the Arctic seismic array jointly owned by the Geological Survey of Denmark and Greenland (GEUS) and Aarhus University. The equipment was designed to obtain high-quality seismic data in the sea-ice covered areas of the Arctic Ocean. The seismic source consisted of two Sercel G-Guns with a volume of 520 in (8.5 L) each mounted on a single frame. Both the airgun array and the streamer cable (Geometrics) were connected to the ship by an armoured umbilical cable to withstand the ice. By only having one cable going in the water, the risk of damage by ice is greatly reduced

compared to standard seismic equipment. The profiles acquired during this expedition will significantly enhance our understanding of the sedimentary and tectonic processes in the Fram Strait.

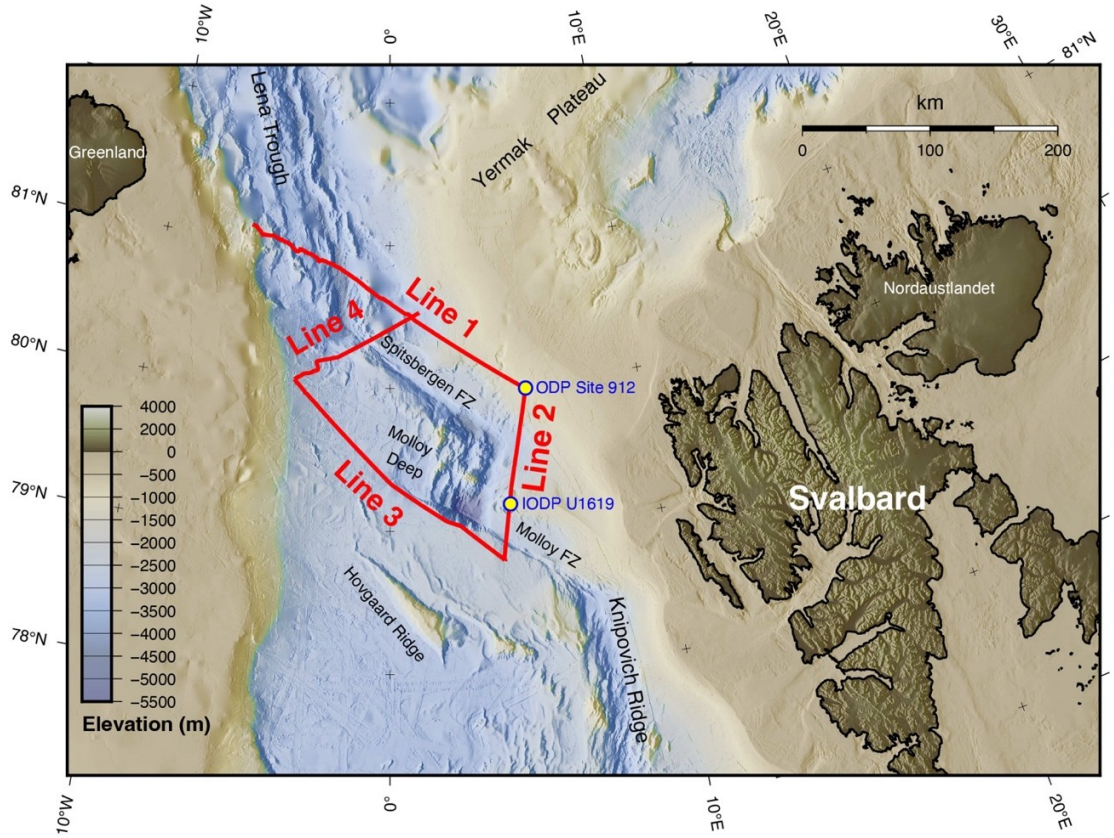


Figure 12: Location of the GoNorth 2024 seismic reflection profiles in the Fram Strait (red lines). Location of the drill sites crossed by the lines, ODP 912 and IODP U1619, is indicated by the yellow circles.

The GEUS/Aarhus University ice array was set up with an offset of 30 m between the airguns and the ship (Figure 13 and 14). The distance between the airguns and channel 1 of the streamer was 9.5 m. To protect the equipment from potential damage by sea ice and to keep it below the propeller wash from the ship, the airgun was towed at a nominal but variable depth of about 20 m below sea level. The speed of the ship generally varied between 3.5 and 4.5 knots depending on the ice situation and sea state. To avoid heavier ice, the ship had to deviate occasionally from a straight run line.

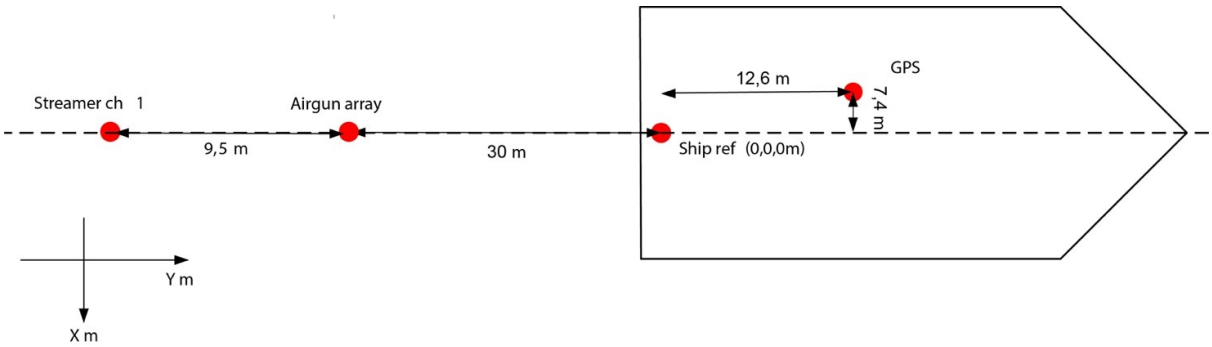


Figure 13: Setup of the seismic equipment with a view from the top. Schematic by Per Trinhammer, Aarhus University.

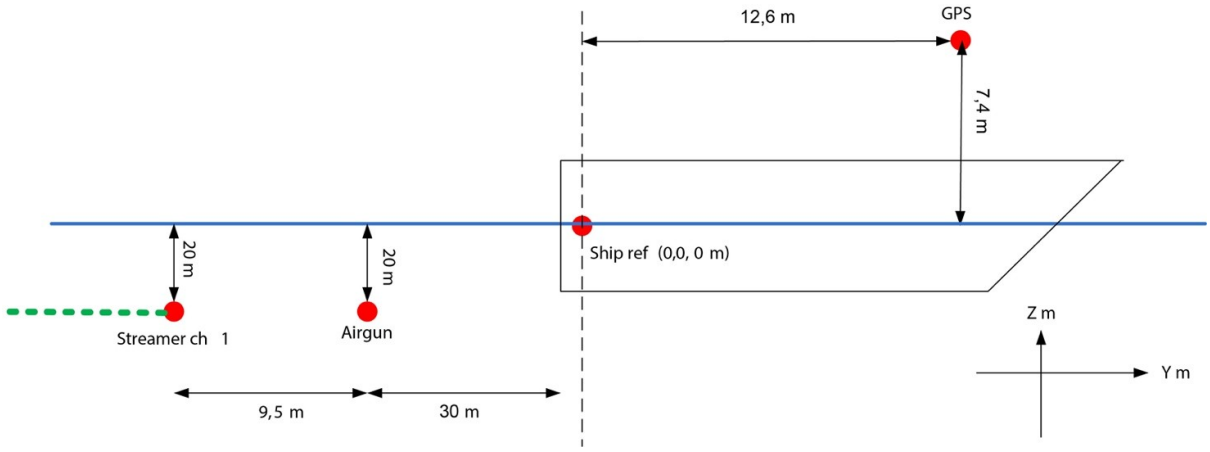


Figure 14: Setup of the seismic equipment with a view from the side. Schematic by Per Trinhammer, AU.

During the acquisition of the seismic reflection data, the air pressure was maintained at approximately 165 bar using the two onboard compressors and a shot interval of 15 s, corresponding to an average shot spacing of 30 m. The deployed streamer comprised of six sections, each containing eight channels with a group spacing of 6.25 m resulting in a total streamer length of 300 m for the 48 channels. Initial real-time processing was conducted during data acquisition, which included normal moveout (NMO) correction, band-pass filtering, gain correction, and stacking traces with laterally variable velocity-depth profiles. The raw data files were saved in SEG-D format for each shot gather, while the stacked data were stored in SEG-Y format.

To prevent potential harm to marine mammals by the seismic operation, mitigation measures were in place during the acquisition. One hour prior to the deployment and during the deployment of the seismic gear, a pre-watch for marine mammals was carried out. For this, four persons were placed on the bridge to cover 90 degrees of the view field each. No whales or other mammals were observed in the 500 m exclusion zone and beyond. After this, the airgun array was ramped up during a 30-min long soft start procedure, in which the number of guns, the air pressure, and shot interval were successively increased to reach the regular acquisition parameters at the end of the period. Three hours prior to the scheduled end of the seismic survey, a blue whale was spotted, and the seismic acquisition was stopped. It was then decided not to resume the acquisition.

Table 9: Overview of the seismic activity onboard.

Line	Start time (UTC)	End time (UTC)	Location first shot	Location last shot	First SEGD file	Last SEGD file	No. of shots	Length (km)
1	Sept. 11, 2024 19:36:57	Sept. 13, 2024 04:52:06	6.232945°W 81.096895°N	5.450689°E 79.954508°N	1	8963	8963	256
2	Sept. 13, 2024 04:56:38	Sept. 13, 2024 22:24:38	5.464064°E 79.949684°N	4.108332°E 78.768424°N	8964	13156	4193	134
3	Sept. 13, 2024 22:28:11	Sept. 15, 2024 01:39:26	4.125504°E 78.767923°N	3.848121°W 80.042288°N	13157	16682	6526	219
4	Sept. 15, 2024 01:42:34	Sept. 15, 2024 16:10:04	3.845265°W 80.045241°N	1.233822°E 80.527471°N	16683	23153	3471	115

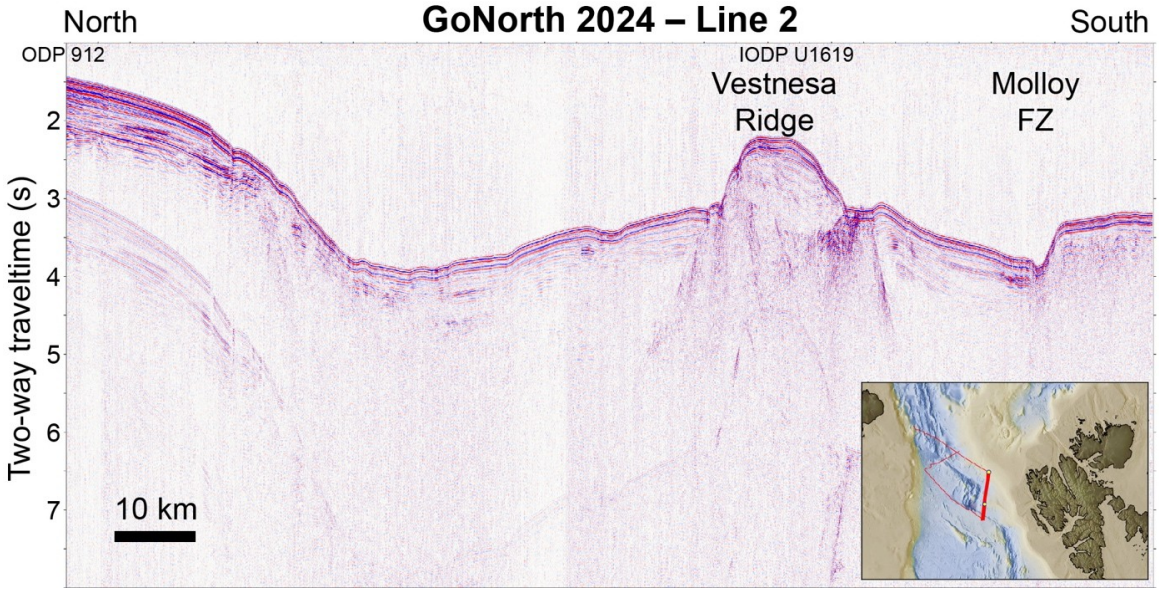


Figure 15: Pre-processed data (brute stack) of seismic reflection data along Line 2 across the Vestnesa Ridge and Molloy Fracture Zone (FZ). The location of the wells ODP Leg 151 Site 912 and IODP Expedition 403 site U1619 are indicated. The bold red line in the inset shows the location of the line.

4.9 Magnetometer

A Cesium marine magnetometer Geometrics G-882 was used to measure magnetic anomalies. The magnetometer was towed about 200 m behind the stern. The geomagnetic reference field was computed using IGRF13 coefficients and coordinate/time information from the EIVA survey computer. The diurnal variation and magnetic storms are monitored based on measurements at the magnetic observatories in Ny-Ålesund and Longyearbyen. The preliminary plots of magnetic anomalies obtained during the survey are compared with data extracted from a regional magnetic anomaly grid (CAMP) and shown in Figure 10.

The magnetometer was run continuously in parallel with the acquisition of seismic data when this was done in ice-free waters.

4.10 Shipborne instrumentation for sea ice analysis

The team from NTNU, consisting of PhD students Md Ashiqul Alam Khan and Oskar Gjesdal Veggeland, investigates how shipborne instrumentations can be used to provide more details about sea ice conditions around the ship. They have designed specialised sensors that have been

mounted on the ship railings, to test the robustness of their systems and collect data to develop algorithms for autonomous analysis of the ice conditions. Brief descriptions of the three systems and their use case are detailed below.

4.10.1. Side-looking ice mapping systems

On the starboard side, outside the bridge, two systems were mounted next to each other as seen in Figure 16. The content of the systems is identical, where the main payloads are an optical camera and a laser scanner (LiDAR), which are used to monitor the environment. The systems are also equipped with an inertial measurement unit and a GNSS receiver such that the pose trajectory can be estimated without relying on ship data, making them completely self-contained. This is desired because it means the system can be placed on any ship without the need for calibration or adaptation. An image of the system content is seen in Figure 16.



Figure 16: Side-looking ice mapping system. To the left, the two instruments are mounted on the railing outside the bridge. The right image shows the content of the systems. Inside the case, on the top row, from left to right is the LiDAR, camera and Arduino (micro-controller). The bottom row contains, from left to right, an IMU (Inertial Measurement Unit), network switch, and a transformer (AC to 12V DC).

The purpose of this system is to create 3D maps of the surrounding ice fields as the ship is sailing along. This is therefore not intended for real-time decision support, but rather a technology intended for large-scale data collection of on-site ice conditions. By equipping ships like R/V Kronprins Haakon with these “passive observers”, we can monitor how local ice conditions change over time and between regions, improving our understanding of how the Arctic environment is developing. For illustrational purposes, we attach an example of what such an ice map might look like and how it can be used to detect ice ridges, a feature caused by pressure in the ice, causing the ice to deform (Figure 17).

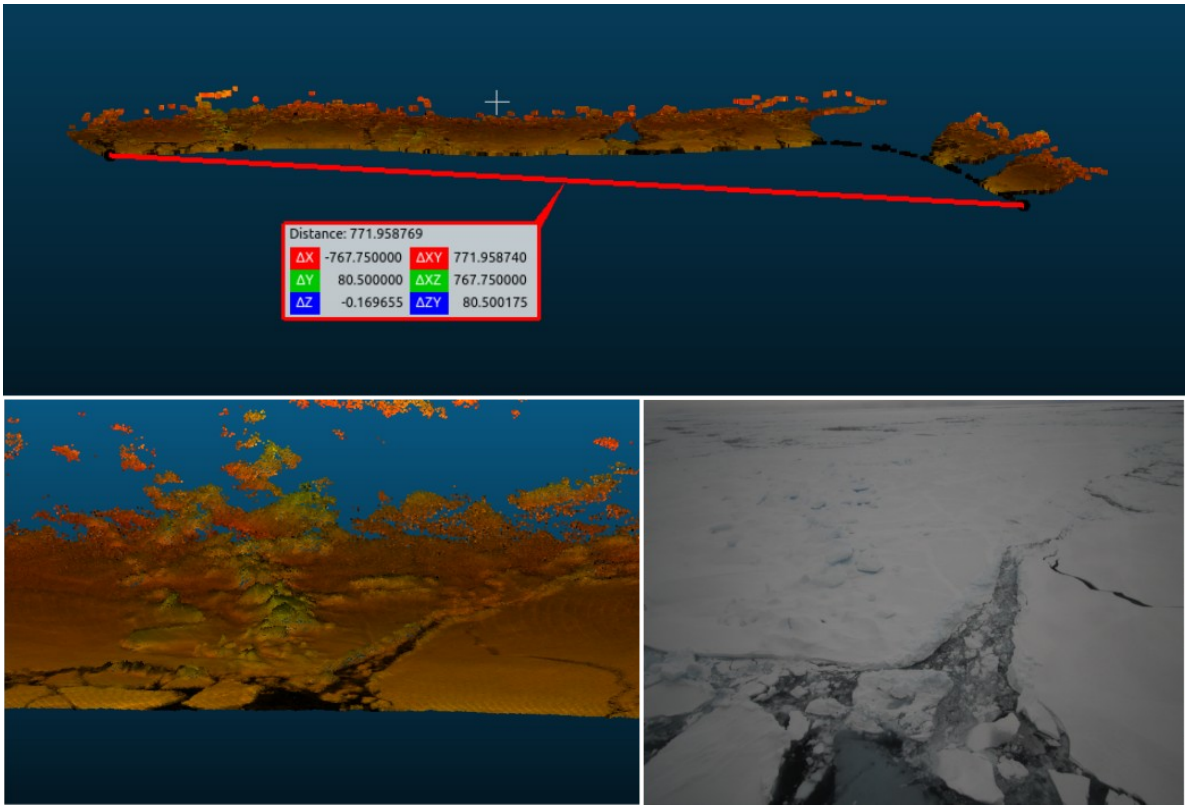


Figure 17: Building large-scale 3D models of the sea ice. In the top image, we see a 3D model constructed from 5 min of continuous measurements with the instrumentation system. In the lower image we have zoomed in on a particular area of interest where there is a big pressure ridge (mountain-chain-looking structure in yellow). To the lower right, we see an optical image of the same area confirming the presence of a ridge, although the flat light makes it hard to see.

4.10.2. Ice thickness measurement

The primary objective of this part of the study is to measure ice thickness using sensor modules strategically placed on a ship. Two sensor modules were deployed, each serving a unique purpose to enhance the accuracy and quality of the data.

4.10.2.1. Sensor module 1 (bow)

This module, positioned at the front (bow) of the ship, was angled downwards at 45 degrees, providing a field of view of the ice spanning 50 to 250 m ahead of the ship with a field of view (FOV) of 70 degree both in horizontal and vertical direction. The module consisted of:

- A LiDAR sensor: used to detect and classify ice type, size, and, if possible, estimate the thickness of incoming ice.
- A monocular camera: working in conjunction with the LiDAR sensor to enhance the detection and classification of the ice.

The combination of LiDAR and monocular camera allowed us to gather data on ice characteristics, such as type (e.g., multi-year ice, first-year ice), structure, and rough thickness estimates. The fusion of LiDAR and camera data also provided a means of classifying ice types for further analysis.

4.10.2.2. Sensor module 2 (middle-port side):

Positioned on the port side, near the middle of the ship, this module was directed straight downwards, observing the broken ice created by the ship's movement (Figure 18). It featured:

- A stereo camera (120 mm baseline): used for the 3D reconstruction of the broken ice. This setup allowed us to measure the thickness of the ice with greater precision. The stereo vision system reconstructed the fragmented ice's geometry, which offered a highly accurate measurement of ice thickness by analysing the broken ice blocks left behind as the ship moved.



Figure 18: Stereo Camera output from Sensor Module 2 (Broken Ice Fragments).

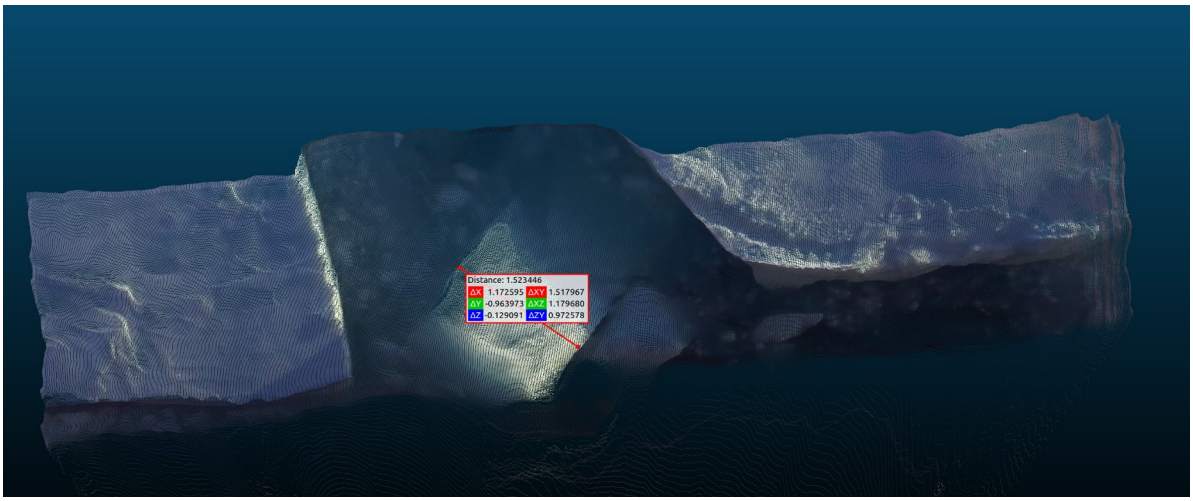


Figure 19: 3D reconstructed scene based on output from stereo camera. Measured approximate ice thickness of 1.523 m.

4.10.2.3. Data collection and ship navigation integration

Both sensor modules were connected to the ship's network, allowing continuous, real-time data collection. Additionally, ship navigation data—including GPS position, speed, heading, and course—was logged in parallel with the sensor data. This allowed for synchronised analysis of sensor readings with the ship's exact position and movement, enhancing the accuracy of ice thickness measurements in relation to the ship's course.

4.10.2.4. Algorithm development

The data collected will be used to develop algorithms aimed at:

- Identifying frames with broken ice blocks that are optimal for estimating thickness through 3D reconstruction from the stereo camera.
- Fusing the LiDAR and camera data from the front module to classify ice types and determine the best estimates for ice thickness ahead of the ship.

This dual-sensor approach enabled robust measurements of both intact and broken ice, providing a reliable means for assessing ice thickness and advancing our understanding of ice conditions for safe navigation in polar regions (Figure 19).

5. Dissemination

Daniel Albert, a senior communications adviser at SINTEF Energy Research, was responsible for creating the daily reports during the expedition. This involved interviewing scientists about their work and capturing images of onboard activities using a Canon R8, an Insta360, and a DJI Mini 3 Pro drone, with occasional use of a Canon 6D Mark II and a Samsung Galaxy S20. The photographs were used in the daily reports, which were published on the project website, as well as distributed to journalists, project partners, and other stakeholders. Daniel also produced both a long and a short video documenting the expedition. Additionally, he facilitated interactions between journalists and expedition members by pitching scientists and story ideas to enhance media coverage. After the expedition, Daniel will compile a picture book that the project can use for advocacy and strategic communication with government officials and other key stakeholders.

6. Projects onboard

6.1 iC3 - Centre for Ice, Cryosphere, Carbon and Climate

PI: Monica Winsborrow (UiT)

Funding: RCN Centre of Excelence

The overall goal of iC3 is to quantify past, present, and future carbon storage and release from ice sheets and how this impacts marine ecosystems and global carbon cycling. On the 2024 GoNorth expedition we have acquired valuable samples of water, sediments and the subsurface in transects from the coastal margins of the Greenland ice sheet to the continental shelf, with a specific focus on Independence Fjord and Hagen Fjord. These samples will allow us to trace ice sheet inputs of meltwater and associated carbon and nutrients, and track their impacts on marine ecosystems and ocean carbon cycle from the ice margin towards the open ocean.

6.2 i2B - Into the Blue – Resolving past Arctic greenhouse climate

PIs: Jochen Knies (UiT, NGU) and Stijn De Schepper (NORCE)

Funding: ERC synergy grant

How the loss of the Arctic's white landscapes will impact our climate, the planet and our society. This is precisely the question that the ERC Synergy Grant "i2B - Into the Blue" wants to get to the bottom of by looking into the past, to a time when the Arctic had a blue, ice-free ocean. To this end, expeditions to the Arctic are planned to quantify the changes from climate archives. The GoNorth expedition in 2024 is important for our main goal to provide analogue process studies of a “blue” (summer sea ice-free) Arctic during past greenhouse climate states. By collecting sediment cores from the northeast Greenland margin and the Yermak Plateau, we will be able to analyse sample material from past greenhouse climate states, i.e. the Pleistocene interglacials (Marine Isotope Stage 5e, the Eemian, and the Marine Isotope Stage 11c, so called super-interglacials, much warmer than today). Indications of a “blue” (summer ice-free) Arctic and associated processes in Arctic marine ecosystems will be achieved by interpreting climate proxy data for sea ice variability and ecosystem changes. The empirical information from these sedimentary archives will used in Earth System Model to improve and validate scenarios of change for the future.

6.3 DYPOLE - Dynamics of polar confined basins – The Eurasia Basin from breakup in greenhouse to present in icehouse conditions

PI: Carmen Gaina (UiO)

Funding: RCN

The main goal of DYPOLE is to understand the interplay between tectonic, magmatic, and sedimentary processes that have shaped the northern Barents Sea–Svalbard margin. It also aims to establish links between the tectono-magmatic history of the Cenozoic Arctic and oceanographic and climatic changes.

Seismic reflection, magnetic and gravity data collected across the Lena Trough and around the deepest point of the Fram Strait, are uniquely linking tectonics (imaged by the seismic data) with sedimentation history (archived in the older Ocean Drilling Programme drillholes and imaged by geophysical data). This will give new insights into the development of the only deep-water gateway between the Arctic and global oceans. The geophysical data collected

during the GoNorth 2024 expedition will be central to unravelling the processes and timing of the transition between a greenhouse to icehouse conditions during the last couple of millions of years.

Research questions that will be addressed includes: 1) When did the opening of the Fram Strait gateway allow for a deep-water connection between the Arctic Ocean and the Atlantic Ocean and establishment of the present ocean circulation system? 2) When did ice caps first establish on Svalbard and in the northern Barents Sea? 3) How did the expansion and retreat of these ice masses influence the storage and release (to the atmosphere) of subsurface greenhouse gases (methane) from gas hydrate systems in this area? For this, we will apply seismic stratigraphic analyses of 2D, and 3D seismic data integrated with multi-beam bathymetry and cores.

For more information on DYPOLE:

https://www.mn.uio.no/geo/english/research/projects/dypole/index.html

6.4 AGENSI – A Genetic View Into Past Sea Ice Variability in the Arctic

PI: Stijn De Schepper (NORCE)

Funding: ERC consolidator grant

The AGENSI project aims to use sedimentary ancient DNA from sea floor sediments in the Arctic Ocean for documenting the biodiversity in the Arctic Ocean, establish new sea ice proxies and reconstruct the past sea ice history. We analyse sea floor surface sediments for DNA analyses (metabarcoding), palynology, and organic biomarkers and include these into the Arctic Surface Sediment DNA Database. The database is used to document the Arctic Ocean sea floor biodiversity and develop new sedimentary ancient DNA based sea ice proxies. Short and long sediment cores are used to reconstruct the Late Quaternary ecosystem and sea ice history of the Arctic Ocean.

The AGENSI project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement No 818449).

6.5 Continental Shelf Project of the Kingdom of Denmark

PI: Thomas Funck (GEUS)

In 2014, the Government of Greenland together with the Government of the Kingdom of Denmark made a submission to the United Nations Commission on the Limits of the Continental Shelf (CLCS) for an extended continental shelf north of Greenland. GEUS was the lead organisation to acquire the scientific data to substantiate the submission that comprises an area of 895 000 km^2. Despite many years of mapping in the Arctic, the perennial ice cover leaves broad regions with little or no data. One particular area with a poor data coverage is located between the Gakkel Ridge and Morris Jesup Rise. The swath-bathymetric and sub-bottom profiler data acquired during the GoNorth 2024 expedition represents a substantial addition to the database of the continental shelf project and will be used for an improved description of this segment of the northern continental margin of Greenland and the sedimentary processes that shaped it. The data will also help our understanding of the Fram Strait as an oceanic gateway. The mapping was done in collaboration with the Danish Geodata Agency (GST) that is the hydrographic office in charge for Greenland. GST expects to use the new depth data to improve save navigation in the region. In particular, the data on the Greenland shelf and in the previously uncharted Independence Fjord will provide valuable

information in areas that will become more accessible in times of global warming and the associated retreat of the Arctic sea ice.

6.6 Climate change, ice dynamics and carbon cycle across the Svalbard-North Greenland transect, PhD project at UNIS

PI: Riko Noormets (UNIS)

Large uncertainties related to the projections of global warming and associated future sea level rise are to a great degree a consequence of an insufficient understanding of the causes and effects of rapid climate shifts in the geological past. Due to polar amplification, the changes resulting from modern climate warming are particularly pronounced in the Arctic. The response of the environment to the changing climate is nonlinear and most likely more abrupt than the current numerical models predict. Global average temperatures are suggested to have been 1–2 °C warmer during the Eemian compared to modern pre-industrial temperatures. Considering that the warming in the Arctic is 3–4 times faster than the global average, the rate of melting will most likely increase exponentially in the near future. Rapid changes in ice sheet extent, configuration and retreat rate have been suggested to coincide with the warming periods and driven by major changes in the ocean. Swift climate changes, rapidly accelerating melting of ice sheets and associated meltwater fluxes, changes in ocean bioproduction, coastal (permafrost) erosion and seafloor gas emissions result in input of carbon from various sources (marine, terrestrial, subsurface). These changes are recorded both in the seafloor morphology and seabed sediments. These geological archives can be used to unravel the processes controlling rapid environmental changes in the past. Rapid development of biomarker-based methods in recent years has, in addition to conventional sedimentological, geophysical and geotechnical approaches, provided a diverse toolbox for detecting such climate signals in the geological records and using these to successfully reconstruct past environmental and climate conditions.

This project will employ a set of conventional geophysical and sedimentological methods as well as novel biomarker-based geochemical methods to study climate changes in Svalbard and in North Greenland with a particular focus on rapid warming periods, such as the Bølling-Allerød and post Younger Dryas early Holocene. Rapid shifts in climate have been shown to be reflected in the rate of deglaciation. The goal of the project is to study these critical periods of environmental shifts in two geographically and climatically different, but crucial areas in Svalbard and Northern Greenland to better understand the patterns and drivers of rapid ice loss and resulting sea level rise. This has broad and important implications for accurate reconstructions of regional as well as pan-Arctic climate necessary for model-based projections of future climate and sea-level scenarios. The project will be closely integrated with large international (GEOEO) and national (GoNorth) research programs. The geophysical data and sediment cores collected during the GoNorth cruise in 2024 will be used to address the questions outlined above.

6.7 PASTIME, Fjo2rd and CLIFORD

PIs: Agnes Weiner and Bjørg Risebrobakken (NORCE)

Funding: RCN: PASTIME - Present and past climate change impacts on Norwegian fjord ecosystems, PI: Agnes Weiner, NORCE, and Fjo2rd - The effect of climate change on the deep water renewal frequency of Norwegian fjords, PI: Elin Darelius, UiB. Utdannings- og forskningsdepartementet (through basic funding to the Centre for Climate Dynamics at the

Bjerknes Centre for Climate Research): CLIFORD - Climate change and sustainability in Norwegian fjords, PI:Mari Myksvoll, IMR.

Climate change and anthropogenic pressures alter costal and fjord environments. However, how these pressures affect the physical and biological environment remains largely unknown. There is a need for a better understanding of what the baseline natural conditions and variability are in coastal and fjord ecosystems, both with respect to the physical and biological environment. Within the projects PASTIME, CLIFORD and Fjo2rd, these unknowns are addressed, by applying a combined paleoecology and paleogenomics (sedimentary ancient DNA) approach. The recent oxygenation history, temperature, salinity and sea ice changes are reconstructed over the last few centuries and the effects of climatic and anthropogenic change on the lower trophic levels (microbial eukaryotes) is investigated in Norwegian and Arctic fjords. The combined focus of the projects is on Norwegian fjords (western Norway and Svalbard), however, the material collected through the GoNorth cruise allows for an expansion of the focus area and a comparison of ecosystem responses seen in highly different environmental settings.

6.8 beAt - Microbial response to Arctic climate variability

PI: Steffen Leth Jørgensen (UiB)

Researchers involved: Ulysses Ninnemann, Hannah Rose Babel.

This interdisciplinary project seeks to map past climate and circulation variability in the Arctic and assess how they are linked to variability in carbon turn-over and the associated microbial communities. The overarching goal is to understand the short- and long-term consequences of ongoing Arctic climate changes. The project is part of research theme II "*from fluids to life*" at the Centre for Deep Sea Research (UiB), and further constitute part of the sample material to be used in ongoing research efforts within the Quaternary and Paleoclimate group (UiB) to understand Arctic−Atlantic circulation and carbon cycling in a warmer world.

6.9 Benthic meiofauna sampling for SUDARCO (Sustainable Development of the Arctic Ocean)

PI: Bodil Bluhm (UiB)

This year's GoNorth sampling of benthic meiofauna support the goals of SUDARCO's work package 4, which is to evaluate the current state of the Arctic Ocean ecosystem and to improve predictive capacity of future changes in that ecosystem. Within it, the benthic work is focused on filling gaps on the knowledge of biodiversity in the Arctic deep sea, in this case with a focus on morphological identification of benthic meiofauna. This work complements samples taken during the 2023 GoNorth cruise, the JC2-2 cruise of the Nansen Legacy in 2021, and video material of the seafloor of the Lomonosov Ridge and Morris Jesup Rise analysed for larger fauna from the 2015 FRAM drift. Within GoNorth, the work is complementary to the metabarcoding studies conducted on benthic biota.

6.10 Intelligent local-scale observations and analytics

PI: Ekaterina Kim (NTNU)

Activities are part of the RCN funded project: Multi-scale integration and digitalisation of Arctic sea ice observations and prediction models (PI: Roger Skjetne).

This is part of a larger initiative where the main objective is to build a multiscale digital infrastructure that integrates regional sea ice forecasting models and local ice–ice/ice–structure numerical models (based on discrete elements) with in-situ, shipboard, and satellite-based Arctic sea ice and environmental observations. The aim is to enable improved spatial and temporal resolution to achieve more precise forecasting of ice conditions in the Arctic — including better understanding of long-term variations in polar ice cover. A common methodology to achieve this is the use of AI-based analytics of synthetic aperture radar (SAR) and optical imagery from satellites, marine radars, and visual and infrared cameras. Activities thought the GoNorth 2024 cruise have mainly been focusing on technology research, particular on intelligent local sea ice observations. It should be possible to use the data gathered by the researchers and extrapolate the results, beyond the project objectives, to maritime safety and more efficient shipping in the Arctic.

6.11 Heat Flow Measurements

PI: Stefan Bünz (UiT)

Mid-ocean ridges are geologically complex systems where new oceanic crust/seafloor forms. They play an important role in the plate tectonics cycle of our planet. Heat flow data is extremely sparse in the Arctic Ocean. There is a particular need for heat flow measurements in perennial ice-covered regions of the Fram Strait and Arctic basin. The overall goal of this project is to improve our understanding of the thermal structure and evolution of the ultra-slow mid-ocean ridge system in the Fram Strait and its adjacent basins. Here, we particularly focus on the plate configuration along the Lena Trough and the transition to the Gakkel Ridge. This work supports WP1 and WP2 of the GoNorth Project and integrates also with the DYPOLE project at UiO. Data will also be transferred to Global Heat Flow Database maintained by the International Heat Flow Commission (IHFC).

7. Abbreviations

Table 10: Definitions of abbreviations used in the text, alphabetically sorted.

Abbreviation	Explanation
2D	Two-dimentional
3D	Three-dimentional
AC	Alternating current
aDNA	Ancient deoxyribonucleic acid
AGENSI	A Genetic View Into Past Sea Ice Variability in the Arctic
AU	Aarhus University
beAt	Microbial response to Arctic climate variability
BIST	Built-In Self Test
CAMP	Circum-Arctic Mapping Project
CLCS	Commission on the Limits of the Continental Shelf
CLIFORD	Climate change and sustainability in Norwegian fjords
CTD	Conductivity, Temperature, and Depth
DC	Direct current
DJI	Name of drone producing Technology company
DTU	Technical University of Denmark
DYPOLE	Dynamics of polar confined basins – The Eurasia Basin from breakup in greenhouse to present in icehouse conditions
EIVA	Company producing software and equipment for maritime survey and engineering operations
EPSG	European Petroleum Survey Group
ERC	European Research Council
Fjo2rd	The effect of climate change on the deep water renewal frequency of Norwegian fjords
FM	Frequency Modulation
FZ	Fracture Zone
GC	Gravity Corer
GEOEO	North Greenland Earth-Ocean-Ecosystem Observatory
GEUS	De Nationale Geologiske Undersøgelser for Danmark & Grønland
GLONASS	Global Navigation Satellite System (GLObalnaya NAvigatsionnaya Sputnikovaya Sistema)
GNSS	Global navigation satellite system
GoNorth	Geoscience in the Northern Arctic
GPS	Global Positioning System
GST	Geodatastyrelsen
i2B	Into the Blue – Resolving past Arctic greenhouse climate
iC3	Centre for Ice, Cryosphere, Carbon and Climate
IGRF	International Geomagnetic Reference Field (https://www.ngdc.noaa.gov/IAGA/vmod/igrf.html)
IHFC	International Heat Flow Commission
IMR	Institute of Marien Research
IMU	Inertial Measurement Unit.
IODP	International Ocean Discovery Program

Abbreviation	Explanation
LiDAR	Light Detection and Ranging
MBES	Multibeam echosounder
MC	Multicorer
MCS	multi-channel seismic
MTD	Mass transport deposit
MVP	Moving velocity profilers
NGU	Geological Survey of Norway
NMEA	National Marine Electronics Association
NORCE	NORCE Norwegian Research Centre AS
NTNU	Norges teknisk-naturvitenskaplige Universitet
ODP	Ocean Drilling Program
PASTIME	Present and past climate change impacts on Norwegian fjord ecosystems
PC	Personal Computer
PPP	Precise Point Positioning
QPS	Company producing maritime software solutions
RCN	The Research Council of Norway
SAR	Synthetic aperture radar
SBP	Sub-bottom profiler
SEG-D	Society of Exploration Geophysicists D Format
SEG-Y	Society of Exploration Geophysicists Y Format
SIS	Seafloor Information System
SUDARCO	Sustainable Development of the Arctic Ocean
UiB	University of Bergen
UiO	University of Oslo
UiT	University of Tromsø - The ArcticUniversity of Norway
UNIS	The University Centre in Svalbard
UTC	Coordinated Universal Time
WGS	World Geodetic System
XTB	Expendable bathythermographs

8. Appendices

Appendices are provided along with this report as supplementary material. A list of the available appendices is provided in Table 11.

Table 11: List of appendices. Appendices are not included for sites where CTD was performed but no water samples or coring were taken.

Appendices	Content
A	Log information from the stations visited.
B	KH24-259-02 Onboard sampling overview
C	KH24-259-03 Onboard sampling overview
D	KH24-259-04 Onboard sampling overview
E	KH24-259-05 Onboard sampling overview
F	KH24-259-06 Onboard sampling overview
G	KH24-259-07 Onboard sampling overview
H	KH24-259-08 Onboard sampling overview
I	KH24-259-09 Onboard sampling overview
J	KH24-259-10 Onboard sampling overview
K	KH24-259-11 Onboard sampling overview
L	KH24-259-12 Onboard sampling overview
M	KH24-259-13 Onboard sampling overview
N	KH24-259-14 Onboard sampling overview
O	KH24-259-15 Onboard sampling overview
P	KH24-259-16 Onboard sampling overview
Q	KH24-259-17 Onboard sampling overview
R	KH24-259-19 Onboard sampling overview
S	KH24-259-20 Onboard sampling overview
T	KH24-259-21 Onboard sampling overview
U	KH24-259-22 Onboard sampling overview
V	KH24-259-23 Onboard sampling overview
W	KH24-259-25 Onboard sampling overview
X	KH24-259-27 Onboard sampling overview
Y	KH24-259-29 Onboard sampling overview
Z	KH24-259-30 Onboard sampling overview
AA	KH24-259-32 Onboard sampling overview